

Chemistry Curriculum

Scranton School District

Scranton, PA

Date

Course Name: Chemistry	**Grade:** 11 or 12
Prerequisites: Biology	
Course Description:	

Course Overview		
Phenomenon / Topic	**Standards / Assessment Anchors**	**Pacing Guide (Suggested Time)**
Behaviors of the elements and the Periodic Table	3.2.9-12.A Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.	4 weeks (20 days; 45 minute classes)
Qualitative analysis of unknowns	3.2.9-12.B Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. 3.2.9-12.N Communicate scientific and technical information about why the molecularlevel structure is important in the functioning of designed materials. 3.2.9-12.V 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. 3.2.9-12.W Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.	5 weeks (25 days; 45 minute classes)
Gravimetric analysis of compounds	3.2.9-12.C Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.	3 weeks (15 days; 45 minute classes)
Types of chemical reactions	3.2.9-12.C Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.	3 weeks (15 days; 45 minute classes)
Thermodynamics	3.2.9-12.D Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.	3 weeks (15 days; 45 minute classes)

	3.2.9-12.O Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. 3.2.9-12.P Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects). 3.2.9-12.R Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).	
Stoichiometry	3.2.9-12.C Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. 3.2.9-12.G Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	6 weeks (30 days; 45 minute classes)
Dynamic Equilibrium	3.2.9-12.F Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.	3 weeks (15 days; 45 minute classes)
Reaction Rates	3.2.9-12.E Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.	3 weeks (15 days; 45 minute classes)
Acid-base chemistry	3.2.9-12.F Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.	3 weeks (15 days; 45 minute classes)
Nuclear chemistry	3.2.9-12.H Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.	3 weeks (15 days; 45 minute classes)

Quarter 1
Detailed Breakdown By Topic

Phenomenon / Topic	Essential Knowledge & Skills	Vocabulary	Resources & Activities
Forensic science: What is the mystery powder? Behavior and properties of substances.	Safety and lab techniques Using analytical techniques, students can determine what unknown substances are based on a predetermined list of unknowns. Substances with different bonds and geometries exhibit vastly different behavior that can be predicted. Demonstrate safe and accurate use of lab equipment, following appropriate lab procedures and protocols. Use qualitative and quantitative methods to analyze and identify unknown substances based on density, solubility, pH, and reactivity. Compare physical and chemical properties of substances to determine bond type (ionic, covalent, metallic) and molecular geometry. Predict properties of substances using intermolecular forces, polarity, and bonding patterns. Analyze experimental data to draw evidence-based conclusions regarding unknown compounds. Apply scientific reasoning and critical thinking to explain how bonding and structure influence observable macroscopic properties. **Honors will add in complex molecular structures and detailed intermolecular forces.**	Density Polarity Acid/Base Intermolecular forces Physical Polarity Specific heat	Flinn scientific Qualitative analysis of 11 unknowns Flinn Scientific Item #: AP4855 Density of unknowns lab* Flinn Scientific Item #: AP6058 Properties of ionic vs. covalent compounds lab Flinn Scientific Item #: AP7691 Specific Heat lab Flinn Scientific Item #: AP7566
Why do the elements produce light of varying colors? How does a neon light work?	Based on the Bohr model and Quantum model of the atom, determine how electron configuration can predict the color of light emitted. Develop and Using Models: Modify the periodic table to add important information concerning electron configuration. Explain the relationship between energy, electron movement, and light emission using the Bohr and quantum models of the atom. Describe how electrons absorb and release energy as they transition between energy	Ionization energy Periodic trends Orbital diagrams Electron configuration Orbital sublevels Valence magnetism	Flame tests lab: Various ionic salts Bunsen burners Spectra tubes Plasma ball Flinn Scientific Item #: AP1716

	levels. Use flame tests and spectroscopy to determine the identity of elements based on their emission spectra. Interpret electron configurations, orbital diagrams, and valence electron patterns to predict reactivity and spectral output. Develop and refine models (e.g., atomic models, periodic table annotations) to represent subatomic interactions and atomic structure. Analyze and interpret patterns in spectral data to explain how electron behavior differs across elements. **Honors will add in electron configuration for atoms larger than 30. Coulomb's Law will also be examined**			
Why do elements on the periodic table have properties that change in predictable ways?	Students will be able to compare and contrast the properties of elements based on group and column Use the periodic table as a tool to predict and explain patterns in properties such as ionization energy, atomic radius, and electronegativity. Identify trends across periods and groups and relate these to the arrangement of electrons and energy levels. Explain the Law of Periodicity and how it reflects recurring patterns in chemical behavior. Compare chemical and physical properties of representative groups (e.g., alkali metals, halogens, noble gases). Construct models and data charts to visualize periodic trends and make predictions about unknown elements. Analyze historical models of the periodic table (e.g., Mendeleev's) and revise them to incorporate modern electron configuration insights. **Honors will add in an experimental design of a rust/reaction inhibitor to determine its effectiveness.**	Ionization energy Electronegativity Atomic radius Law of periodicity octet	Mendeleev Lab Flinn Scientific Item #: AP6289 3D periodic table activity Determine the radius of an atom activity	

Quarter 2
Detailed Breakdown By Topic

Phenomenon / Topic	Essential Knowledge & Skills	Vocabulary	Resources & Activities	
What is the formula for this compound? What is its name?	Students perform various experiments to produce products and determine the empirical formulas of these products. Use observational and experimental data to determine the empirical and molecular formulas of unknown substances. Apply the law of conservation of mass and the mole concept to determine molar ratios in compounds. Use IUPAC rules to name and write formulas for ionic and molecular compounds. Draw Lewis structures to represent covalent bonding and molecular geometry, applying the octet rule. Relate bonding types (ionic, covalent, metallic) to properties such as conductivity, solubility, and melting point. Use percent composition and hydrates to determine the formula of a compound. **Honors will consider percent composition**	Reactants Products Empirical mole Nomenclature Lewis structure Octet	Nomenclature Analysis of various Hydrates lab Calculate and determine the empirical formula for a hydrated crystal. Flinn Scientific Item #: AP7032 Perform a chemical reaction to determine the formula of a compound.	For ass info hav wor Ma tea Tim Gra Ass Sho Ind Pro Des Des Per Vid Cre
What are the different types of chemical reactions seen in everyday life?	Students will be able to distinguish different types of chemical reactions based on the changes that reactants undergo. Identify and classify chemical reactions: synthesis, decomposition, single replacement, double replacement, and combustion. Predict products of chemical reactions based on reactant types and reactivity series. Explain chemical changes by tracking the rearrangement of atoms and conservation of mass. Use evidence (e.g., color change, gas formation, precipitate) to differentiate physical and chemical changes. Analyze how redox reactions are involved in corrosion, combustion, and biological processes. Design and interpret data from precipitation and gas formation reactions. **Honors will look at caloric content**	Synthesis decomposition single displacement (replacement) double displacement oxidation and reduction precipitate	Magnesium oxide synthesis lab Silver nitrate and hydrochloric acid precipitate lab Precipitation reactions Flinn Scientific Item #: AP4862	For ass info hav wor Ma tea Tim Gra Ass Sho Ind Pro Des Des Per Vid Cre
Chemical/Physical reaction enthalpy:	Students will perform experiments on physical and chemical reactions and the energy and heat transfers associated with both.	Phase changes Bond energies	Experiments measuring melting point, boiling point.	For ass info

How does an ice pack / hot pack produce energy?	Differentiate between physical and chemical changes in terms of energy transfer and molecular interactions. Use calorimetry data to calculate heat absorbed or released in endothermic and exothermic processes. Explain specific heat capacity and its role in determining temperature changes in substances. Analyze phase changes and bond energy changes to determine total enthalpy change. Apply the principles of energy conservation and enthalpy to real-life engineering challenges such as designing a hand warmer or cold pack. Use experimental data and calculations to evaluate the efficiency of thermal systems. **Honors will add calculations for enthalpy and Gibbs free energy**	Equilibrium Calorimetry Endothermic Exothermic Specific heat capacity	Designing a hand warmer Flinn Scientific AP#7654 Heat of fusion of a fatty acid (lauric acid) Heat of reaction: calcium oxide and water	hav wor Ma tea Tim Gra Ass Sho Ind Pro Des Des Per Vid Cre

Quarter 3
Detailed Breakdown By Topic

Phenomenon / Topic	Essential Knowledge & Skills	Vocabulary	Resources & Activities
Stoichiometry: How much product is produced for different chemical reactions?	Using mathematics and computation to determine theoretical and percent yield for a variety of chemical reactions in the solid, liquid and gas phase. Use the Law of Conservation of Mass to balance chemical equations and relate moles of reactants to products. Apply molar mass and mole-to-mole ratios to convert between grams, moles, particles, and volume (for gases at STP). Calculate theoretical yield and percent yield using experimental and calculated data. Justify stoichiometric calculations with dimensional analysis and proportional reasoning. Predict and analyze reaction outcomes by comparing experimental results with theoretical predictions. Interpret stoichiometric ratios using particle diagrams and balanced chemical equations. **Honors will add ideal gas law**	Law of conservation of mass Molar mass Balancing equations	Copper and silver nitrate or a comparable experiment to determine the amount of a product produced using stoichiometry Flinn Scientific Item #: AP6363
What determines the amount of product that is created by a chemical reaction?	Using mathematics to predict the outcome of chemical reactions and which reactant is limiting and in excess. Identify and analyze limiting and excess reactants using mole ratios and chemical reaction data. Determine theoretical yield and percent yield in reactions with limiting reactants. Relate molarity and solution concentration to the amount of reactants and products in a chemical reaction. Design investigations to explore how the amount of a reactant affects the yield of a product. Evaluate experimental procedures for accuracy in predicting yields and identifying limiting reagents. Apply stoichiometry in real-world contexts such as pharmaceuticals, energy systems, or manufacturing. **Honors will add in electrochemistry reactions**	Limiting/excess reactants Law of conservation of mass Theoretical yield Molarity	Target Stoichiometry lab Flinn Item #: AP8483 Limiting reagent lab Flinn Item #: AP4678
Dynamic equilibrium: How do variable changes in chemical reactions affect the products	Students will examine specific reactions where the variables can be manipulated to produce different amounts of products. Explain the concept of chemical equilibrium as a dynamic process where forward and reverse reactions occur at equal rates.	Phase changes Le Chatelier's principle Temperature Pressure concentration	Several demonstrations: Cobalt chloride Ferric thiocyanate Starch iodine reaction Copper ammonia complex Application of Le Chatelier's Principle

and reactants of chemical reactions?	Use Le Chatelier's Principle to predict how changes in concentration, temperature, and pressure affect the position of equilibrium. Conduct experiments and analyze visual indicators of shifts in equilibrium systems (e.g., color change in reversible reactions). Develop and interpret models to demonstrate how equilibrium responds to environmental changes. Evaluate how systems adjust to restore equilibrium and apply this understanding to real-world systems like atmospheric balance, industrial reactions, or physiological processes. Use quantitative reasoning and graphical data to explain equilibrium shifts. **Honors will examine gas stoichiometry and solution stoichiometry**		Flinn Scientific Item #: AP7659	t

Quarter 4
Detailed Breakdown By Topic

Phenomenon / Topic	Essential Knowledge & Skills	Vocabulary	Resources & Activities
What speeds up or slows down a chemical reaction?	Students will refine the design of a chemical system by changing conditions to produce different results. Explain the Collision Theory and how it relates to the rate of chemical reactions. Analyze the effect of temperature, surface area, concentration, and catalysts on reaction rates. Design and conduct investigations to collect rate data and graph reaction kinetics. Interpret rate vs. time graphs and use evidence to justify how different variables influence the speed of reactions. Evaluate chemical system designs and propose modifications to optimize reaction conditions (e.g., industrial synthesis or food preservation). Apply scientific reasoning to predict how altering conditions will affect the rate of a reaction in lab and real-world scenarios.	Collision theory Temperature Concentration Reaction kinetics Surface area	Iodine clock reaction lab Rate of decomposition of calcium carbonate Flinn Scientific Item#: AP7648
What classifies a chemical as an acid or a base and what is its behavior?	Students will examine a variety of materials to observe their acid and basic nature and reactions to produce them and reactions between them. Distinguish between acids and bases using their physical and chemical properties and the pH scale. Use indicators and pH meters to test and classify common substances. Explore acid-base reactions (neutralization) and relate them to real-world applications (e.g., digestion, antacids, buffers). Perform titrations and interpret data to calculate concentrations of unknown solutions. Model acid-base equilibria and explain the role of buffers in maintaining pH stability. Analyze how acid-base chemistry impacts environmental and biological systems (e.g., acid rain, blood pH). **Honors will add several acid/base titration types.**	pH Acid-base equilibrium Buffers Indicators	Acid-base titrations - Classic Lab Kit Flinn Scientific Item# AP9083 Sodium hydroxide pellets vinegar aspirin
Nuclear reactions: What happens in nuclear power	Students develop models to demonstrate nuclei composition changes resulting in alpha, beta, and gamma decay. Real-life applications of carbon dating	Alpha particle Beta particle Gamma particle Fission	Chain reaction simulation Nuclear power plant simulation

plants/bombs to produce energy? Half-life: How can we use nuclear chemistry to determine the age of organisms and the Earth?	Compare nuclear reactions (fission, fusion) with chemical reactions in terms of energy change, mass change, and particle emission. Model and explain the processes of alpha, beta, gamma decay and positron emission, and their effects on atomic structure. Use the concept of half-life to calculate the age of materials through radiometric dating techniques (e.g., carbon dating). Evaluate the benefits and risks of nuclear technologies including power generation, weapons, and medical uses. Design and interpret simulations (e.g., dice/penny labs) to visualize the random nature of radioactive decay. Use nuclear chemistry concepts to explain the challenges of nuclear waste disposal, energy policy, and isotope use in medicine and research. **Honors will also look at decay series and uranium/lead dating**	Fusion Positron emission	PHeT Colorado nuclear reaction web lab Dice/Penny half life Flinn Scientific Item #: AP8009	