**Building:** RCHS **Course:** Chemistry **Grade:** 10,11,12 **Tier:** DC **Approved:** E (Baxter) C (Troxel) A (Lemke / Perkins)

**PLC Question #1:** What do we want all students to know and be able to do?

| Unit 1: Measurement and Classification of Matter ✅ | Unit 2: Atoms, Molecules, and Ions ✅ | Unit 3: Electronic Structure and Periodic Properties of Elements ✅ |
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| **Priority Standard(s)**<br>• HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.<br>• Develop mathematical and visual models of error analysis, and apply this analysis to experimentation utilizing the scientific method.<br>• Develop models to illustrate the concept of an atom vs a molecule, a pure substance vs a mixture, and a homogeneous mixture vs a heterogeneous mixture | **Priority Standard(s)**<br>• HS-PS1-8. 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.<br>• Develop models to illustrate the subatomic particles in an atom, and use that model to explain size ratio, location, and composition of the subatomic particles in the atom<br>• Construct a timeline and explanation on the development of our current understanding of atomic theory | **Priority Standard(s)**<br>• HS-PS1-1. 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 an atom.<br>• HS-PS1-2. 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.<br>• HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. |
| **Supporting Standard(s)**<br>• Utilize techniques of observation to differentiate between chemical and physical changes, chemical and physical properties.<br>• Use measurements to support mathematical representations to support the Law of Conservation of Matter | **Supporting Standard(s)**<br>• HS-PS4-2. Evaluate questions about the advantages of using digital transmission and storage of information.<br>• Use laboratory measurement techniques to construct models to aid in understanding atomic structure | **Supporting Standard(s)**<br>• HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.<br>• HS-PS4-3. 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. |

**Learning Outcomes**

| Students need to know (concrete knowledge)<br>• Ex. vocabulary, facts, concepts, etc. | DOK Level | Students need to know (concrete knowledge)<br>• Ex. vocabulary, facts, concepts, etc. | DOK Level | Students need to know (concrete knowledge)<br>• Ex. vocabulary, facts, concepts, etc. | DOK Level |
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| • Distinguish between elements and compounds<br>• Distinguish between mixtures and pure substances.<br>• Distinguish between chemical and physical changes.<br>• Distinguish between solid, liquid, and gas.<br>• Distinguish between accuracy and precision. | | • Know contributions of Dalton, JJ Thomson, Rutherford, Millikan<br>• Count protons, neutrons, and electrons in atoms and ions.<br>• Define and recognize isotopes.<br>• Know what Z indicates.<br>• formulas. | | • Name the three phenomena observed that eventually led to our understanding of electron arrangement<br>• Know how to use n2 and 2n2, know how many sublevels are in an energy level<br>• Know how Coulomb's law influences periodic trends and ion formation. | |
| **Students will understand (abstract ideas)**<br>• Ex. connections, relationships, frameworks, etc. | **DOK Level** | **Students will understand (abstract ideas)**<br>• Ex. connections, relationships, frameworks, etc. | **DOK Level** | **Students will understand (abstract ideas)**<br>• Ex. connections, relationships, frameworks, etc. | **DOK Level** |
| • How atoms of different elements are different from each other<br>• How atoms of the same elements are different from each other<br>• Necessity and purpose of the atomic mass unit<br>• Purpose, value, and application of ratios in | | • Dalton's atomic theory and how it has changed with new discoveries<br>• Distinguish between elements and compounds.<br>• Recognize and explain Dalton's atomic theory.<br>• Read a periodic table entry.<br>• Count the number of atoms in a molecule/formula | | • Relate an element's electron configuration to its position in the periodic table<br>• Understand periodic trends in atomic radii (size), electron affinity, and ionization energy, and electronegativity<br>• Identify elements with similar valence electron | |

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| scientific problem solving<br>• Explain the difference between a theory and a law. | | unit. | | configuration and relate this to the concept of periodicity<br>• Recognize s, p, and d orbitals based on shape, and know that the angular momentum quantum number (l) designates shape.<br>• Decide the relative energy of electron sublevels<br>• Predict the relative ionization energy of elements<br>• Predict ions formed by main-group elements<br>• Predict whether a compound is ionic or molecular and predict the formulae of these compounds (including polyatomic ions)<br>• Understand the organization of the electromagnetic spectrum | |
| **Students will do (active application)** | **DOK Level** | **Students will do (active application)** | **DOK Level** | **Students will do (active application)** | **DOK Level** |
| • Be able to perform dimensional analysis problems.<br>• How to calculate and graph data to find density<br>• Convert ℃ to K, and K to ℃. | | • Calculate molar mass, grams, moles, particles (atoms or molecules).<br>• Determine empirical formulas from molecular formulas. | | • Write and interpret electron configuration for atoms and ions<br>• Be able to convert between wavelength, frequency and energy of photons<br>• Assign quantum numbers. | |
| **Domain-specific Vocabulary** | | **Domain-specific Vocabulary** | | **Domain-specific Vocabulary** | |
| accuracy, atom, Celsius (°C), chemical change, chemical property, chemistry, compound, cubic centimeter ($cm^3$ or cc), cubic meter ($m^3$), density, dimensional analysis, element, exact number, extensive property, Fahrenheit, gas, heterogeneous mixture, homogeneous mixture, hypothesis, intensive property, kelvin (K), kilogram (kg), law, law of conservation of matter, length, liquid, liter (L), macroscopic domain, mass, matter, meter (m), microscopic domain, milliliter (mL), mixture, molecule, physical change, physical property, plasma, precision, pure substance, rounding, scientific method, second (s), SI units (International System of Units), significant figures, solid, symbolic domain, temperature, theory, uncertainty, unit, unit conversion factor, volume, weight | | alpha particle (α particle), anion, atomic mass, atomic mass unit (amu), atomic number (Z), cation, chemical symbol, Dalton (Da) Dalton's atomic theory, electron, empirical formula, fundamental unit of charge, ion, isomers, isotopes, law of constant composition, law of definite proportions, law of multiple proportions, mass number (A), molecular formula, neutron, nucleus, proton, spatial isomers, structural formula, structural isomer, unified atomic mass unit (u) | | actinide, alkali metal, alkaline earth metal, amplitude, atomic orbital, Aufbau principle, blackbody radiation, Bohr's model,, continuous spectrum, core electron, covalent bond, covalent compound, covalent radius, d orbital, effective nuclear charge, electromagnetic radiation, electromagnetic spectrum, electron affinity, electron configuration, electron density, energy level, excited state, f orbital, frequency, ground state, group, halogen, Heisenberg uncertainty principle, hertz (Hz), Hund's rule, inert gas, inner transition metal, intensity, ionic bond, ionization energy, isoelectric, lanthanide, line spectrum, main group element, metalloid, molecular compound, monatomic ion, noble gas, node, orbital diagram, p orbital, Pauli exclusion principle, period, periodic law, periodic table, photon, polyatomic ion, quantum numbers, representative element, s orbital, series, sublevel, transition metal, valence electrons, wave, wavelength | |

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**PLC Question #1:** What do we want all students to know and be able to do?

| Unit 4: Chemical Bonding and Molecular Geometry ✅ | Unit 5: Advanced Theories of Bonding ✅ | Unit 6: Composition of Substances and Solutions ✅ |
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| **Priority Standard(s)**<br>• HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.<br>• Use models to determine spatial arrangement and geometry of molecule and polyatomic ions<br>• Apply understanding of electrostatic forces to electron arrangement in molecules, and how this arrangement influences macroscopic properties of substances | **Priority Standard(s)**<br>• HS-PS1-3. 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.<br>• HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.<br>• Construct an explanation for the phenomenon of magnetism, and be able to identify various types (ferro vs. para) | **Priority Standard(s)**<br>• Use mathematical models to represent element and compound compositions<br>• Use mathematical models to represent composition of mixtures, with an emphasis on aqueous solutions<br>• Recognize and understand the use of mathematical models that pertain to various classifications of matter |
| **Supporting Standard(s)**<br>• HS-PS1-1. 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 an atom.<br>• HS-PS1-2. 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. | **Supporting Standard(s)**<br>• Use various models to represent organic molecules, and evaluate these models based on how effectively they communicate pertinent information about these organic molecules<br>• Make connections between the micro properties of molecules and the macro properties of substances through laboratory investigation | **Supporting Standard(s)**<br>• Analyze chemical compounds in the laboratory setting to learn their composition<br>• Analyze solutions in the laboratory setting to learn their composition |

| Learning Outcomes | | Learning Outcomes | | Learning Outcomes | |
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| **Students need to know (concrete knowledge)**<br>• Ex. vocabulary, facts, concepts, etc. | **DOK Level** | **Students need to know (concrete knowledge)**<br>• Ex. vocabulary, facts, concepts, etc. | **DOK Level** | **Students need to know (concrete knowledge)**<br>• Ex. vocabulary, facts, concepts, etc. | **DOK Level** |
| • Name and write the formula of covalent compounds.<br>• Name and write the formula of ionic compounds, including compounds with various charge metals, compounds containing polyatomic ions, and ionic hydrates<br>• Name and write the formula of acids. | | • Know what valence bond theory is<br>• Name the types of hybridization found in molecules | | • Know the difference between atomic mass, formula mass, molecular mass, and molar mass<br>• Know how to use the periodic table as a reference | |
| **Students will understand (abstract ideas)**<br>• Ex. connections, relationships, frameworks, etc. | **DOK Level** | **Students will understand (abstract ideas)**<br>• Ex. connections, relationships, frameworks, etc. | **DOK Level** | **Students will understand (abstract ideas)**<br>• Ex. connections, relationships, frameworks, etc. | **DOK Level** |
| • Predict ions formed by common main-group elements<br>• Predict whether a compound is ionic or molecular (or covalent)<br>• Predict the formula of ionic compounds (including polyatomic ions)<br>• Predict the relative electronegativity of atoms<br>• Decide whether a Lewis structure satisfies the | | • Understand how determined bond angles could not be explained using valence bond theory<br>• Decipher molecular shape from central atom hybridization | | • Use the periodic table to determine elements and compounds<br>• Use the periodic table to determine element and compound masses<br>• Differentiate between particle mass and molar mass | |

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| octet rule<br>• Recognize exceptions to the octet rule<br>• Predict and name the arrangement of electron groups around a central atom<br>• Describe the shapes of molecules, including bond angles<br>• Predict whether molecules are polar or nonpolar | | | | | |
| **Students will do (active application)** | **DOK Level** | **Students will do (active application)** | **DOK Level** | **Students will do (active application)** | **DOK Level** |
| • Draw the Lewis dot diagram of a main group atom or common atomic ion<br>• Count the valence electrons in a molecule or polyatomic ion<br>• Count bonding and nonbonding electron pairs in a Lewis structure<br>• Write Lewis structures for molecules<br>• Write the Lewis structures for a molecule with resonance<br>• Calculate formal charge | | • Describe specific orbital overlap in forming bonds<br>• Predict the relative length and energy of chemical bonds<br>• Count sigma and pi bonds in a molecule<br>• Identify hybridization in a molecule<br>• Identify intermolecular forces present in a molecule<br>• Differentiate between macro properties (boiling points) based on strengths of intermolecular forces present | | • Calculate atomic mass, formula mass, molecular mass, and molar mass<br>• Calculate percent composition from data<br>• Calculate percent composition from a formula<br>• Calculate empirical formula from data (g or %)<br>• Calculate molecular formula<br>• Calculate molarity<br>• Interconvert molarity of solutions with solute moles or mass<br>• Calculate concentration or volume of diluted solutions<br>• Calculate mole fraction<br>• Calculate molarity from various “percentage” solutions (“30% by mass, 30% by volume, 30% mass/volume” for example) | |
| **Domain-specific Vocabulary** | | **Domain-specific Vocabulary** | | **Domain-specific Vocabulary** | |
| axial position, binary acid, binary compound, bond angle, bond dipole moment, bond distance, bond length, covalent bond, dipole moment, double bond, electron-pair geometry, electronegativity, equatorial position, formal charge, free radical, hypervalent molecule, inert pair effect, ionic bond, Lewis structures, Lewis symbol, linear, lone pair, molecular structure, nomenclature, octahedral, octet rule, polar covalent bond, polar molecule, pure covalent bond, resonance, single bond, skeleton structure, tetrahedral, trigonal bipyramidal, trigonal planar, triple bond, VSEPR | | antibonding orbital, bond order, bonding orbital, degenerate orbitals, diamagnetism, homonuclear diatomic molecules, hybrid orbital, hybridization, linear combination of atomic orbitals, molecular orbital, molecular orbital diagram, molecular orbital theory, node, overlap, paramagnetism, pi bond, s-p mixing, sigma bond, sp hybrid orbital, $sp^2$ hybrid orbital, $sp^3$ hybrid orbital, $sp^3d$ hybrid orbital, $sp^3d^2$ hybrid orbital, valence bond theory | | aqueous solution, Avogadro’s number, concentrated, concentration, dilute, dilution, dissolved, empirical formula, empirical formula mass, formula mass, mass percentage, mass-volume percent, molar mass, molarity (M), mole, mole fraction, molecular formula, molecular mass, parts per billion (ppb), parts per million (ppm), percent composition, solute, solvent, volume percentage | |

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| Unit 7: Stoichiometry of Chemical Reactions ✅ | Unit 8: Gases ✅ | Unit 9: Thermochemistry ✅ |
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| **Priority Standard(s)**<br>• HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.<br>• HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.<br>• Identify reactants and products in a chemical reaction, and use these to understand how matter rearranges during reactions | **Priority Standard(s)**<br>• Use graphical models to illustrate the interconnectedness of variables that describe a quantity of gas<br>• Recognize and describe the behaviour of the gaseous state of matter<br>• Develop graphical and mathematical models based on observations of how one variable in a scientific investigation affects another variable | **Priority Standard(s)**<br>• HS-PS1-5. 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.<br>• HS-PS3-1. 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.<br>• HS-PS3-4. 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). |
| **Supporting Standard(s)**<br>• Explore the Law of Conservation of Matter through multiple cycles<br>• Refine measurement and data collection skills in the chemistry laboratory | **Supporting Standard(s)**<br>• HS-PS3-2. 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).<br>• Recognize the complexity of various units of measurement (gas pressure in this instance) | **Supporting Standard(s)**<br>• HS-PS3-2. 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).<br>• HS-PS1-4. 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. |
| **Learning Outcomes** | **Learning Outcomes** | **Learning Outcomes** |
| **Students need to know (concrete knowledge)**<br>• Ex. vocabulary, facts, concepts, etc. — **DOK Level** | **Students need to know (concrete knowledge)**<br>• Ex. vocabulary, facts, concepts, etc. — **DOK Level** | **Students need to know (concrete knowledge)**<br>• Ex. vocabulary, facts, concepts, etc. — **DOK Level** |
| • Understand/interpret/know how to use the Activity Series<br>• Define and predict precipitation reactions<br>• Define and recognize oxidation-reduction reactions, and classify redox reactions as combustion, combination/synthesis, decomposition, or single displacement | • Know the variables that are used to describe a quantity of gas<br>• Recognize various units to measure pressure, temperature, volume and quantity<br>• Know how variables that describe gases are related to one another and how these relationships are graphically represented | • Use examples to define and describe the difference between system and surroundings, and temperature and heat<br>• Recall temperature scales and absolute zero<br>• Know that temperature is measured, while heat is calculated |
| **Students will understand (abstract ideas)**<br>• Ex. connections, relationships, frameworks, etc. — **DOK Level** | **Students will understand (abstract ideas)**<br>• Ex. connections, relationships, frameworks, etc. — **DOK Level** | **Students will understand (abstract ideas)**<br>• Ex. connections, relationships, frameworks, etc. — **DOK Level** |
| • Interpret stoichiometric coefficients in terms of molecules or moles | • Use kinetic molecular theory to explain properties of ideal gases | • Interpret the First Law of Thermodynamics<br>• Distinguish exothermic and endothermic |

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| • Identify acids and bases<br>• Use a chemical equation to relate amounts and products (mass, moles, or molarity)<br>• Identify a limiting reactant | | • Understand how kinetic energy scales compare with temperature<br>• Understand how molecular speeds vary with temperature and molar mass<br>• Describe effusion and diffusion<br>• Describe factors that lead to deviation from ideal gas behavior<br>• Use the van der Waals equation to find properties of non ideal gases and explain why deviations occur | | processes, and heat vs temperature (short answer with examples)<br>• Write a standard formation reaction<br>• Recognize combustion reactions of hydrocarbons<br>• Determine relative strengths of lattice energies | |
| **Students will do (active application)** | **DOK Level** | **Students will do (active application)** | **DOK Level** | **Students will do (active application)** | **DOK Level** |
| • Balance chemical equations and know what symbols in chemical equations mean, know the terms reactant, product, coefficient<br>• Use the formula of a compound to find the moles of ions in solution<br>• Predict the products of a neutralization reaction<br>• Calculate theoretical and percent yields of chemical reactions<br>• Determine the volume of base needed to titrate a given amount of acid | | • Interconvert pressure units (pascals, atmospheres, Torr, mmHg)<br>• Use the ideal gas law to calculate properties of gases<br>• Use the combined gas law to calculate properties of gases<br>• Interconvert molar mass and density of ideal gases<br>• Perform stoichiometric calculations involving gases<br>• Calculate partial pressures of gases with and without mole fractions; calculate mole fractions | | • Use heat capacity to find heat or temperature change; use $q = m \times \Delta T \times c$ equation and be able to solve for each variable<br>• Find the equilibrium temperature when substances at different temperatures mix<br>• Calculate heat of reaction from constant-pressure calorimetry data<br>• Use conservation of energy to calculate reaction enthalpy under changed conditions<br>• Use Hess's Law to calculate net reaction enthalpy<br>• Calculate a molar heat of reaction from formation enthalpies<br>• Solve stoichiometry thermochemistry problems<br>• Find enthalpy of reaction from bond energies | |
| **Domain-specific Vocabulary** | | **Domain-specific Vocabulary** | | **Domain-specific Vocabulary** | |
| acid, acid-base reaction, actual yield, analyte, balanced equation, base, buret, chemical equation, coefficient, combustion analysis, combustion reaction, complete ionic equation, end point, equivalence point, excess reactant, gravimetric analysis, half-reaction, indicator, insoluble, limiting reactant, molecular equation, net ionic equation, neutralization reaction, oxidation, oxidation number, oxidation-reduction reaction, oxidizing agent, percent yield, precipitate, precipitation reaction, product, quantitative analysis, reactant, reducing agent, reduction, salt, single-displacement reaction, solubility, soluble, spectator ion, stoichiometric factor, stoichiometry, strong acid, strong base, theoretical yield, titrant, titration, weak acid, weak base | | absolute zero, Amonton's law, atmosphere (atm) Avogadro's law, bar, barometer, Boyle's law, Charles's Law, compressibility factor, Dalton's law of partial pressure, diffusion, effusion, Gay-Lussac's Law, Graham's Law of Diffusion/Effusion, hydrostatic pressure, ideal gas, ideal gas constant, ideal gas law, kinetic molecular theory, manometer, mean free path, mole fraction, partial pressure, pascal, pounds per square inch, pressure, rate of diffusion, root mean square speed, standard conditions of temperature and pressure, standard molar volume, torr, van der Waals equation, vapor pressure of water | | bomb calorimeter, bond energy, Born-Haber cycle, calorie, calorimeter, calorimetry, chemical thermodynamics, endothermic process, energy, enthalpy, enthalpy change, exothermic process, expansion work (pressure-volume work), first law of thermodynamics, heat, heat capacity, Hess's law, hydrocarbon, internal energy, joule, kinetic energy, lattice energy, nutritional calorie, potential energy, specific heat capacity, standard enthalpy of combustion, standard enthalpy of formation, standard state, state function, surroundings, system, temperature, thermal energy, thermochemistry, work | |