- **PSC1-HS-1**. Develop models to describe the atomic composition of simple molecules and extended structures.
  - Clarification Statement: Emphasis is on reviewing how to develop models of molecules that vary in complexity. This should build on the similar middle school standard (PS1-MS-1). Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamond. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.
  - Assessment Limit: Students will be provided with the names of the elements, a list of common ions, a list of numerical prefixes and their meanings, and the charges of all cations and anions within the item as necessary. Confine element symbols to the representative and familiar transition metal elements.

Criteria	**Advanced Understanding of Standard (4)**	**Proficient Understanding of Standard (3)**	**Approaching and Understanding of Standard (2)**	**Beginning, Does Not Meet Standard (1)**	**Non-Performance (0, M, I)**
Describe the atomic composition of a simple molecule.	Student can write chemical formulas (empirical and molecular) and calculate formula mass.	Student can write chemical formulas and calculate formula mass.	Student can write a chemical formula.	Student cannot write chemical formulas.	Not enough evidence to determine performance.
Relate the composition of single molecules to the geometry of the extended structure.	Student applies "proficient criteria" using examples not directly taught in class.	Student can relate atomic composition to molecular structure.	Student can describe atomic composition but not molecular structure.	Students cannot describe atomic composition or molecular structure	Not enough evidence to determine performance.
Draw/Communicate various molecular-level models depicting atomic composition.	Student applies "proficient criteria" and can correctly predict/describe bond angles.	Student can draw Lewis structures for atoms and molecules. Ball and stick models of molecules.	Lewis structure for an atom but not a molecule.	Student cannot draw a Lewis Structure.	Not enough evidence to determine performance.

- **<u>PSC1-HS-2</u>**. 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.
  - Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.
  - Assessment Limit: Elements will be limited to main group elements. Properties assessed will be limited to reactivity, valence electrons, atomic radius, electronegativity, ionization energy (first), shielding effect, and the most common oxidation number.

Criteria	**Advanced Understanding of Standard (4)**	**Proficient Understanding of Standard (3)**	**Approaching and Understanding of Standard (2)**	**Beginning, Does Not Meet Standard (1)**	**Non-Performance (0, M, I)**
Predict Chemical Properties of elements based on the pattern of electrons in the outermost energy level (valence electrons)	All criteria from "proficient understanding" and student can describe both the quantum and classical model of electron orbitals.	Student can describe chemical reactivity based on the number of valence electrons.	Students can describe the valence electrons but cannot relate that to chemical reactivity.	Student cannot describe valence electrons nor chemical reactivity	Not enough evidence to determine performance.
Draw Bohr Models and Lewis Structures to help predict chemical properties/reactivity	All criteria from "proficient understanding" and student can use examples not directly taught in class.	Student can predict chemical reactivity from Bohr models and Lewis structures.	Student can create Bohr models and Lewis structures but cannot predict chemical properties.	Student cannot create Bohr models nor Lewis structures and cannot predict chemical properties.	Not enough evidence to determine performance.
Describe the type of bond formed based on what atoms are involved in the bond.	All criteria from "proficient understanding" and student can successfully describe all three types of bonding: ionic, covalent(polar/non-polar), and metal-metal bonding.	Student can determine the type of bond (ionic/covalent) based on the atoms present.	Student can identify the atoms present but cannot determine the type of bond.	Student cannot identify atoms present nor determine the type of bond.	Not enough evidence to determine performance.

- **PSC2-HS-1**. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states (configurations) of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
  - Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.
  - Assessment Limit: Identify types of chemical reactions including: synthesis/formation/combination reactions, decomposition reactions, single replacement/displacement reactions, double replacement/displacement reactions, oxidation-redox reactions, acid-base reactions, and combustion reactions. Predict the products of double replacement, single replacement, and combustion reactions only. For the second skill statement, do not use acid names or hydrocarbons when translating between words and formulas. Items will include a list of common ions as needed.

Criteria	**Advanced Understanding of Standard (4)**	**Proficient Understanding of Standard (3)**	**Approaching and Understanding of Standard (2)**	**Beginning, Does Not Meet Standard (1)**	**Non-Performance (0, M, I)**
Predict the results/products of a chemical reaction based on valence electrons and chemical periodicity.	All "proficient understanding" and can also use examples not directly used in class.	Student can predict the products of a chemical reaction based on the reactants.	Students can sometimes predict the products of a chemical reaction.	Student cannot predict the products of a chemical reaction if given the reactants.	Not enough evidence to evaluate student performance.
Identify the type of chemical reaction depicted in a chemical equation.	All "proficient understanding" and can label the reaction as exothermic or endothermic.	Given a complete chemical equation students can identify the type of reaction depicted.	Students can sometimes identify the type of chemical reaction.	Students cannot identify the type of chemical reaction based on chemical equations.	Not enough evidence to evaluate student performance.
Write a complete, balanced chemical equation if given the reactants.	All "proficient understanding" plus student can calculate percent yield and identify excess/limiting reactant.	Given the chemical formula of reactants students can complete and balance the chemical equation.	Student can write a chemical equation but not balance it.	Students cannot write a complete, balanced equation.	Not enough evidence to evaluate student performance.

- **PSC2-HS-2**. Develop a model to illustrate the release or absorption of energy from a chemical reaction depends upon the changes in total bond energy.
  - Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.
  - Assessment Limit: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of the reactants and products.

Criteria	**Advanced Understanding of Standard (4)**	**Proficient Understanding of Standard (3)**	**Approaching and Understanding of Standard (2)**	**Beginning, Does Not Meet Standard (1)**	**Non-Performance (0, M, I)**
Describe a chemical reaction specifically including energy as a product or reactant.	Student meets proficient requirements AND can describe/calculate bond energy differences between the products/reactants	Student can represent a chemical reaction using an equation that includes energy as a product or reactant.	Student can represent a chemical reaction with an equation but not including energy as a product or reactant.	Student cannot represent a chemical reaction, and the associated energy changes, with an equation.	Not enough evidence to evaluate student performance.
Identify an exothermic vs. endothermic reaction based on temperature measurements.	Student meets proficient requirements AND can identify exothermic vs. endothermic reactions not specifically demonstrated in class.	Student can determine if a chemical reaction releases or absorbs energy using temperature measurements and chemical equations.	Student can determine if a chemical reaction releases or absorbs energy using temperature measurements but not using chemical equations.	Student cannot determine if a chemical reaction releases or absorbs energy using temperature measurements nor chemical equations.	Not enough evidence to evaluate student performance.
Apply the Law of Conservation of Energy to a chemical reaction.	Student meets proficient requirements AND can apply the Law of Conservation of Energy to conditions or examples not specifically taught in class.	Student can describe the temperature difference between the products/reactants of a chemical reaction in terms of total energy.	Student can identify the temperature difference between products/reactants but cannot comment on the total energy of the system.	Student cannot identify the temperature difference between products/reactants and cannot comment on the total energy of the system.	Not enough evidence to evaluate student performance.

- **PSC2-HS-4**. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
  - Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques. Should also include calculations related to determining the concentration and/or pH of a solution.
  - Assessment Limit: Conversion problems will be one to two steps (e.eg, grams to moles to atoms/molecules). Compounds and formulas should be provided in the stem of the equation. Students should be given molecular masses in problems involving gram to other unit conversions. Molar mass calculations should not be combined with conversion problems. All volumes must be at standard temperature and pressure (STP). A balanced equation and molar masses should be included in the item. Calculations may include grams/moles/volume of reactant to grams/moles/volume of product.

Criteria	**Advanced Understanding of Standard (4)**	**Proficient Understanding of Standard (3)**	**Approaching and Understanding of Standard (2)**	**Beginning, Does Not Meet Standard (1)**	**Non-Performance (0, M, I)**
Describe the Law of Conservation of Mass in relation to a chemical reaction.	Student meets proficient requirements AND can apply the Law of Conservation of Mass to examples not specifically covered in class.	Student can track the total mass of reactants and products using chemical equations and molar masses.	Student knows what the terms conservation and mass mean but cannot relate them to a chemical reaction.	Student cannot describe the law of Conservation of Mass in relation to a chemical reaction.	Not enough evidence to evaluate student performance.
Use the concept of a mole to convert between the number of atoms/molecules and mass (in grams).	Student meets proficient requirements AND can calculate the expected yield of a product in a chemical reaction.	Student can convert between the number of atoms/molecules in a sample and the mass in grams.	Student can describe what a mole is but cannot convert between the number of atoms/molecules and the mass in grams.	Student cannot convert between the number of atoms/molecules in a sample and the mass in grams.	Not enough evidence to evaluate student performance.
Determine the concentration of a solution.	Student meets proficient requirements AND can calculate concentration in parts per million, parts per billion, and percent composition.	Student can determine the concentration of a solution in grams/unit volume (L) and moles/unit volume (L) (molarity).	Student can determine the concentration of a solution in grams/liter.	Student cannot determine the concentration of a solution.	Not enough evidence to evaluate student performance.
Determine the pH of a solution.	Student meets proficient requirements AND can calculate the concentration of Hydronium Ions (H^+ or H_3O^+) if given the pH of a solution.	Student can calculate the Molarity (moles/liter) of Hydronium Ions (H^+ or H_3O^+) in a solution and use $pH = -\log[H+]$	Student can measure pH using a pH-meter or pH-paper.	Student cannot measure pH.	Not enough evidence to evaluate student performance.

- **PSC1-HS-4**. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the process of fission, fusion, and other types of radioactive decay.
  - Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.
  - Assessment Limit: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decay.

Criteria	Advanced Understanding of Standard (4)	Proficient Understanding of Standard (3)	Approaching and Understanding of Standard (2)	Beginning, Does Not Meet Standard (1)	Non-Performance (0, M, I)
Understand how the processes of Fission & Fusion occur. Specifically what changes happen in the nucleus of atoms undergoing Fission and Fusion.	Student meets proficient requirements AND can comment on the difference between fission and fusion in terms of radioactive waste.	Student can describe what happens to the nucleus of atoms undergoing the process of fission and fusion.	Student can state what fission and fusion are but cannot describe what happens to the nucleus of atoms undergoing fission and fusion.	Student does not understand the process of Fission and Fusion. Student cannot describe changes to the nucleus of atoms undergoing fission and fusion.	Not enough evidence to evaluate student performance.
Describe what happens to a nucleus during Alpha, Beta, & Gamma Decay Processes	Student meets proficient requirements AND can identify the relative energy associated with each in addition to what material is necessary to block the decay products.	Student can describe what happens to a nucleus during Alpha, Beta, and Gamma Decay.	Student can state what Alpha, Beta, and Gamma decay are but cannot describe what is happening to the nucleus of atoms undergoing Alpha, Beta, and Gamma decay.	Student does not understand what happens to a nucleus during Alpha, Beta, & Gamma decay.	Not enough evidence to evaluate student performance.
Understand what makes a nucleus stable vs. unstable (radioactive)	Student meets proficient requirements AND discuss the stability/instability of nuclei in terms of the strong nuclear force, the electrostatic force, and the ratio/arrangement of protons to neutrons.	Student can demonstrate what makes a nucleus stable vs. unstable (radioactive)	Student can relate radioactivity to unstable nuclei but cannot describe what makes a nucleus stable vs. unstable.	Student cannot describe what makes a nucleus stable vs. unstable (radioactive)	Not enough evidence to evaluate student performance.

- **PSC3-HS-3**. 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). (Kinetic Molecular Theory)
  - Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy. Examples of models include diagrams, drawings, descriptions, computer simulations.
  - Assessment Limit: Provide equations for the gas laws (i.e., ideal gas laws, Boyle's Law, Charles' Law, and combined gas laws.)

Criteria	Advanced Understanding of Standard (4)	Proficient Understanding of Standard (3)	Approaching an Understanding of Standard (2)	Beginning, Does Not Meet Standard (1)	Non-Performance (0, M, I)
Understand and use The Kinetic Molecular Theory of Matter to describe various states of matter.	Student meets proficient requirements AND can use it to explain why the Kelvin temperature scale has a minimum value but no maximum value.	Student can describe the KMT by relating the state of matter to the kinetic energy of particles in a given example.	Student can relate the state of matter to temperature but cannot describe the state of matter in terms of molecular motion.	Student does not understand the KMT and cannot describe the motion of particles in various states of matter.	Not enough evidence to evaluate student performance.
Understand Charles' Law and use it to calculate volume & temperature.	Student meets proficient requirements AND understands that it only applies when pressure is held constant.	Student can describe Charles' Law and use it to calculate volume & temperature.	Student can state Charles' law but cannot calculate volume & temperature.	Student does not understand Charles' Law and cannot perform calculations.	Not enough evidence to evaluate student performance.
Understand Boyle's Law and use it to calculate volume and pressure.	Student meets proficient requirements AND understands it only applies when temperature is held constant.	Student can describe Boyle's Law and use it to calculate volume & pressure.	Student can state Boyle's law but cannot calculate volume & pressure.	Student does not understand Boyle's Law and cannot perform calculations.	Not enough evidence to evaluate student performance.
Describe Avogadro's Law	Student meets proficient requirements AND understands it only applies to an ideal gas.	Student demonstrates an understanding of Avogadro's Law.	Student understands what volume, temperature, and pressure but cannot relate these to the number of molecules present.	Student cannot describe Avogadro's Law	Not enough evidence to evaluate student performance.
Understand The Ideal Gas Law and use it to calculate pressure, volume, and temperature.	Student meets proficient requirements AND can identify what makes a gas "ideal" differentiating between an ideal and a non-ideal gas. Student also recognizes that the Ideal Gas Law is a combination of Charles', Boyle's, and Avogadro's Law	Student can describe the Ideal Gas Law and use it to calculate pressure, volume, and temperature.		Student does not understand the Ideal Gas Law and cannot perform calculations.	Not enough evidence to evaluate student performance.