Standard	Description	Correlation	Type
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 atoms.**		
HS-PS1-1	From the given model, students identify and describe* the components of the model that are relevant for their predictions, Elements and their arrangement in the periodic table;	p. 63, ¶1 p. 63, ¶3 p. 63, ¶4 p. 132, ¶5	SB Content SB Content SB Content SB Content
HS-PS1-1	From the given model, students identify and describe* the components of the model that are relevant for their predictions, A positively-charged nucleus composed of both protons and neutrons, surrounded by negatively-charged electrons	p. 132, ¶2 p. 132, ¶6	SB Content SB Content
HS-PS1-1	From the given model, students identify and describe* the components of the model that are relevant for their predictions, Electrons in the outermost energy level of atoms (i.e., valence electrons);	p. 280, ¶4	SB Content
HS-PS1-1	From the given model, students identify and describe* the components of the model that are relevant for their predictions, The number of protons in each element.	p. 62, ¶3	SB Content
HS-PS1-1	Students identify and describe* the following relationships between components in the given model,The arrangement of the main groups of the periodic table reflects the patterns of outermost electrons.	p. 271, ¶1	SB Content
HS-PS1-1	Students identify and describe* the following relationships between components in the given model, Elements in the periodic table are arranged by the numbers of protons in atoms.	p. 64, ¶2	SB Content
HS-PS1-1	Students use the periodic table to predict the patterns of behavior of the elements based on the attraction and repulsion between electrically charged particles and the patterns of outermost electrons that determine the typical reactivity of an atom.	p. 281, ¶3	SB Content
HS-PS1-1	Students predict the following patterns of properties: The number and types of bonds formed (i.e. ionic, covalent, metallic) by an element and between elements;	p. 281, ¶3	SB Content
HS-PS1-1	Students predict the following patterns of properties: The number and charges in stable ions that form from atoms in a group of the periodic table	p. 278, ¶1 p. 278, ¶6 p. 279, ¶3	SB Content SB Content SB Content

HS-PS1-1	Students predict the following patterns of properties: The trend in reactivity and electronegativity of atoms down a group, and across a row in the periodic table, based on attractions of outermost (valence) electrons to the nucleus;	p. 308, ¶3	SB Content
HS-PS1-1	Students predict the following patterns of properties: The relative sizes of atoms both across a row and down a group in the periodic table.	p. 285, ¶1 p. 285, ¶3	SB Content SB Content
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.**		
HS-PS1-2	Students construct an explanation of the outcome of the given reaction, including: The idea that the total number of atoms of each element in the reactant and products is the same	p. 195, ¶4	SB Content
HS-PS1-2	Students construct an explanation of the outcome of the given reaction, including: The idea that the total number of atoms of each element in the reactant and products is the same; The numbers and types of bonds (i.e., ionic, covalent) that each atom forms, as determined by the outermost (valence) electron states and the electronegativity;	p. 195, ¶4 p. 308, ¶7	SB Content SB Content
HS-PS1-2	Students construct an explanation of the outcome of the given reaction, including: The outermost (valence) electron state of the atoms that make up both the reactants and the products of the reaction is based on their position in the periodic table;	p. 281, ¶3	SB Content
HS-PS1-2	Students construct an explanation of the outcome of the given reaction, including: A discussion of how the patterns of attraction allow the prediction of the type of reaction that occurs (e.g., formation of ionic compounds, combustion of hydrocarbons).	p. 208, ¶4 p. 208, ¶8	SB Content SB Content
HS-PS1-2	Students identify and describe the evidence to construct the explanation, including: Identification of the products and reactants, including their chemical formulas and the arrangement of their outermost (valence) electrons	p. 281, ¶1 p. 281, ¶3	SB Content SB Content
HS-PS1-2	Students identify and describe the evidence to construct the explanation, including: Identification of the numbers and types of bonds (i.e., ionic, covalent) in both the reactants and the products	p. 357, ¶6	SB Content
HS-PS1-2	Students identify and describe the evidence to construct the explanation, including: The patterns of reactivity (e.g., the high reactivity of alkali metals) at the macroscopic level as determined by using the periodic table;	p. 278, ¶3	SB Content
HS-PS1-2	Students describe their reasoning that connects the evidence, along with the assumption that theories and laws that describe their natural world operate today as they did in the past and will continue to do so in the future, to construct an explanation for how the patterns of outermost electrons and the electronegativity of elements can be used to predict the number and types of bonds each element forms.	p. 308, ¶1 p. 308, ¶7	SB Content SB Content
HS-PS1-2	Given new evidence or context, students construct a revised or	p. 203, ¶3	SB Content

HS-PS1-2	Given new evidence or context, students construct a revised or expanded explanation about the outcome of a chemical reaction and justify the revision.	p. 205, ¶3	SB Content
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.**		
HS-PS1-3	Students describe the phenomenon under investigation, which includes the following idea: the relationship between the measurable properties (e.g., melting point, boiling point, vapor pressure, surface tension) of a substance and the strength of the electrical forces between the particles of the substance.	N/A	
HS-PS1-3	Students develop an investigation plan and describe the data that will be collected and the evidence to be derived from the data, including bulk properties of a substance (e.g., melting point and boiling point, volatility, surface tension) that would allow inferences to be made about the strength of electrical forces between particles.	p. 148, ¶9	SB Content
HS-PS1-3	Students describe why the data about bulk properties would provide information about strength of the electrical forces between the particles of the chosen substances, including the following descriptions: The spacing of the particles of the chosen substances can change as a result of the experimental procedure even if the identity of the particles does not change (e.g., when water is boiled the molecules are still present but further apart).	p. 113, ¶1	SB Content
HS-PS1-3	Students describe why the data about bulk properties would provide information about strength of the electrical forces between the particles of the chosen substances, including the following descriptions: Thermal (kinetic) energy has an effect on the ability of the electrical attraction between particles to keep the particles close together. Thus, as more energy is added to the system, the forces of attraction between the particles can no longer keep the particles close together	p. 396, ¶3	SB Content
HS-PS1-3	Students describe why the data about bulk properties would provide information about strength of the electrical forces between the particles of the chosen substances, including the following descriptions: The patterns of interactions between particles at the molecular scale are reflected in the patterns of behavior at the macroscopic scale.	p. 6, ¶1	SB Content
HS-PS1-3	In the investigation plan, students include: A description of how the data will be collected, the number of trials, and the experimental set up and equipment required.	p. 37, ¶10	SB Content
HS-PS1-3	Students evaluate their investigation, including evaluation of: Assessing the accuracy and precision of the data collected, as well as the limitations of the investigation;	p. 36, ¶1	SB Content
HS-PS1-3	Students evaluate their investigation, including evaluation of: The ability of the data to provide the evidence required.	p. 78, ¶8	SB Content
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.**		

HS-PS1-4	Students use evidence to develop a model in which they identify and describe the relevant components, including: The chemical reaction, the system, and the surroundings under study	p. 102, ¶3	SB Content
HS-PS1-4	Students use evidence to develop a model in which they identify and describe the relevant components, including: The bonds that are broken during the course of the reaction	p. 357, ¶6	SB Content
HS-PS1-4	Students use evidence to develop a model in which they identify and describe the relevant components, including: The bonds that are formed during the course of the reaction	p. 357, ¶6	SB Content
HS-PS1-4	Students use evidence to develop a model in which they identify and describe the relevant components, including: The energy transfer between the systems and their components or the system and surroundings	p. 362, ¶4 p. 362, ¶6	SB Content SB Content
HS-PS1-4	Students use evidence to develop a model in which they identify and describe the relevant components, including: The transformation of potential energy from the chemical system interactions to kinetic energy in the surroundings (or vice versa) by molecular collisions;	p. 450, ¶5	SB Content
HS-PS1-4	Students use evidence to develop a model in which they identify and describe the relevant components, including: The relative potential energies of the reactants and the products.	N/A	
HS-PS1-4	Students use the developed model to illustrate: The energy change within the system is accounted for by the change in the bond energies of the reactants and products. (Note: This does not include calculating the total bond energy changes.)	p. 357, ¶1	SB Content
HS-PS1-4	Students use the developed model to illustrate: Breaking bonds requires an input of energy from the system or surroundings, and forming bonds releases energy to the system and the surroundings	p. 357, ¶1	SB Content
HS-PS1-4	Students use the developed model to illustrate: The energy transfer between systems and surroundings is the difference in energy between the bond energies of the reactants and the products.	p. 362, ¶4	SB Content
HS-PS1-4	Students use the developed model to illustrate: The overall energy of the system and surroundings is unchanged (conserved) during the reaction.	p. 102, ¶5	SB Content
HS-PS1-4	Students use the developed model to illustrate: Energy transfer occurs during molecular collisions	p. 450, ¶5	SB Content
HS-PS1-5	**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.**		
HS-PS1-5	Students construct an explanation that includes the idea that as the kinetic energy of colliding particles increases and the number of collisions increases, the reaction rate increases.	p. 451, ¶1	SB Content
HS-PS1-5	Students identify and describe* evidence to construct the	p. 168, ¶3	SB Content

	explanation, including: Evidence (e.g., from a table of data) of a pattern that increases in concentration (e.g., a change in one concentration while the other concentration is held constant) increase the reaction rate, and vice versa;		
HS-PS1-5	Students identify and describe* evidence to construct the explanation, including: Evidence of a pattern that increases in temperature usually increase the reaction rate, and vice versa.	p. 451, ¶4	SB Content
HS-PS1-5	Students use and describe* the following chain of reasoning that integrates evidence, facts, and scientific principles to construct the explanation: Molecules that collide can break bonds and form new bonds, producing new molecules.	p. 450, ¶3	SB Content
HS-PS1-5	Students use and describe* the following chain of reasoning that integrates evidence, facts, and scientific principles to construct the explanation: The probability of bonds breaking in the collision depends on the kinetic energy of the collision being sufficient to break the bond, since bond breaking requires energy.	p. 450, ¶5	SB Content
HS-PS1-5	Students use and describe* the following chain of reasoning that integrates evidence, facts, and scientific principles to construct the explanation: Since temperature is a measure of average kinetic energy, a higher temperature means that molecular collisions will, on average, be more likely to break bonds and form new bonds.	p. 98, ¶3	SB Content
HS-PS1-5	Students use and describe* the following chain of reasoning that integrates evidence, facts, and scientific principles to construct the explanation: At a fixed concentration, molecules that are moving faster also collide more frequently, so molecules with higher kinetic energy are likely to collide more often.	p. 97, ¶6	SB Content
HS-PS1-5	Students use and describe* the following chain of reasoning that integrates evidence, facts, and scientific principles to construct the explanation: A high concentration means that there are more molecules in a given volume and thus more particle collisions per unit of time at the same temperature.	p. 451, ¶2	SB Content
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.***		
HS-PS1-6	Students identify and describe* potential changes in a component of the given chemical reaction system that will increase the amounts of particular species at equilibrium. Students use evidence to describe* the relative quantities of a product before and after changes to a given chemical reaction system (e.g., concentration increases, decreases, or stays the same), and will explicitly use Le Chatelier's principle, including: How, at a molecular level, a stress involving a change to one component of an equilibrium system affects other components	p. 168, ¶3 p. 492, ¶4	SB Content SB Content
HS-PS1-6	Students identify and describe* potential changes in a component of the given chemical reaction system that will increase the amounts of particular species at equilibrium. Students use evidence to describe* the relative quantities of a product before and after changes to a given chemical reaction	p. 492, ¶4	SB Content

	system (e.g., concentration increases, decreases, or stays the same), and will explicitly use Le Chatelier's principle, including: That changing the concentration of one of the components of the equilibrium system will change the rate of the reaction (forward or backward) in which it is a reactant, until the forward and backward rates are again equal;		
HS-PS1-6	Students identify and describe* potential changes in a component of the given chemical reaction system that will increase the amounts of particular species at equilibrium. Students use evidence to describe* the relative quantities of a product before and after changes to a given chemical reaction system (e.g., concentration increases, decreases, or stays the same), and will explicitly use Le Chatelier's principle, including: A description* of a system at equilibrium that includes the idea that both the forward and backward reactions are occurring at the same rate, resulting in a system that appears stable at the macroscopic level.	p. 492, ¶4	SB Content
HS-PS1-6	Students describe* the prioritized criteria and constraints, and quantify each when appropriate. Examples of constraints to be considered are cost, energy required to produce a product, hazardous nature and chemical properties of reactants and products, and availability of resources.	p. 37, ¶3	SB Content
HS-PS1-6	Students refine the given designed system by making tradeoffs that would optimize the designed system to increase the amount of product, and describe* the reasoning behind design decisions.	p. 37, ¶3	SB Content
HS-PS1-7	**Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction**		
HS-PS1-7	Students identify and describe the relevant components in the mathematical representations: Quantities of reactants and products of a chemical reaction in terms of atoms, moles, and mass	p. 227, ¶1	SB Content
HS-PS1-7	Students identify and describe the relevant components in the mathematical representations: Molar mass of all components of the reaction	p. 228, ¶1	SB Content
HS-PS1-7	Students identify and describe the relevant components in the mathematical representations: Use of balanced chemical equation(s);	p. 224, ¶4	SB Content
HS-PS1-7	Students identify and describe the relevant components in the mathematical representations: Identification of the claim that atoms, and therefore mass, are conserved during a chemical reaction.	p. 232, ¶3	SB Content
HS-PS1-7	The mathematical representations may include numerical calculations, graphs, or other pictorial depictions of quantitative information.	p. 390, ¶4	SB Content
HS-PS1-7	Students identify the claim to be supported: that atoms, and therefore mass, are conserved during a chemical reaction.	p. 195, ¶1	SB Content
HS-PS1-7	Students use the mole to convert between the atomic and macroscopic scale in the analysis	p. 166, ¶3	SB Content

	macroscopic scale in the analysis.		
HS-PS1-7	Given a chemical reaction, students use the mathematical representations to Predict the relative number of atoms in the reactants versus the products at the atomic molecular scale;	p. 230, ¶1	SB Content
HS-PS1-7	Given a chemical reaction, students use the mathematical representations to Calculate the mass of any component of a reaction, given any other component	p. 227, ¶1	SB Content
HS-PS1-7	Students describe how the mathematical representations (e.g., stoichiometric calculations to show that the number of atoms or number of moles is unchanged after a chemical reaction where a specific mass of reactant is converted to product) support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	p. 224, ¶1	SB Content
HS-PS1-7	Students describe how the mass of a substance can be used to determine the number of atoms, molecules, or ions using moles and mole relationships (e.g., macroscopic to atomic molecular scale conversion using the number of moles and Avogadro's number).	p. 230, ¶1	SB Content
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.**		
HS-PS1-8	Students develop models in which they identify and describe* the relevant components of the models, including: Identification of an element by the number of protons	p. 64, ¶2	SB Content
HS-PS1-8	Students develop models in which they identify and describe* the relevant components of the models, including: The number of protons and neutrons in the nucleus before and after the decay	p. 611, ¶3 p. 612, ¶2 p. 613, ¶3	SB Content SB Content SB Content
HS-PS1-8	Students develop models in which they identify and describe* the relevant components of the models, including: The identity of the emitted particles (i.e., alpha, beta – both electrons and positrons, and gamma);	p. 611, ¶3 p. 612, ¶2 p. 613, ¶3	SB Content SB Content SB Content
HS-PS1-8	Students develop models in which they identify and describe* the relevant components of the models, including: The scale of energy changes associated with nuclear processes, relative to the scale of energy changes associated with chemical processes.	p. 620, ¶1	SB Content
HS-PS1-8	Students develop five distinct models to illustrate the relationships between components underlying the nuclear processes of 1) fission, 2) fusion and 3) three distinct types of radioactive decay.	p. 611, ¶3 p. 612, ¶2 p. 613, ¶3 p. 621, ¶3 p. 624, ¶3	SB Content SB Content SB Content SB Content SB Content
HS-PS1-8	Students include the following features, based on evidence, in all five models: The scale of energy changes in a nuclear process is much larger (hundreds of thousands or even millions of times larger) than the scale of energy changes in a chemical process.	p. 620, ¶1	SB Content
HS-PS1-8	Students develop a fusion model that illustrates a process in which two nuclei merge to form a single, larger nucleus with a	p. 624, ¶2	SB Content

	which two nuclei merge to form a single, larger nucleus with a larger number of protons than were in either of the two original nuclei.		
HS-PS1-8	Students develop a fission model that illustrates a process in which a nucleus splits into two or more fragments that each have a smaller number of protons than were in the original nucleus.	p. 621, ¶3	SB Content
HS-PS1-8	In both the fission and fusion models, students illustrate that these processes may release energy and may require initial energy for the reaction to take place.	p. 620, ¶7	SB Content
HS-PS1-8	Students develop radioactive decay models that describe* that alpha particle emission is a type of fission reaction, and that beta and gamma emission are not.	p. 610, ¶5	SB Content
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 position of particles (objects).**		
HS-PS3-2	Students develop models in which they identify and describe the relevant components, including: All the components of the system and the surroundings, as well as energy flows between the system and the surroundings	p. 102, ¶3	SB Content
HS-PS3-2	Students develop models in which they identify and describe the relevant components, including: Clearly depicting both a macroscopic and a molecular/atomic-level representation of the system;	p. 61, ¶1	SB Content
HS-PS3-2	Students develop models in which they identify and describe the relevant components, including: Depicting the forms in which energy is manifested at two different scales: Molecular/atomic, such as motions (kinetic energy) of particles (e.g., nuclei and electrons), the relative positions of particles in fields (potential energy), and energy in fields	p. 96, ¶1	SB Content
HS-PS3-2	Students use their 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 on both the macroscopic and microscopic scales	p. 96, ¶6	SB Content
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).**		
HS-PS3-4	Students develop an investigation plan and describe* the data that will be collected and the evidence to be derived from the data, including: The measurement of the reduction of temperature of the hot object and the increase in temperature of the cold object to show that the thermal energy lost by the hot object is equal to the thermal energy gained by the cold object and that the distribution of thermal energy is more uniform after the interaction of the hot and cold components;	p. 20, ¶1	SB Content
HS-PS3-4	Students develop an investigation plan and describe* the data	p. 25, ¶3	SB Content

	that will be collected and the evidence to be derived from the data, including: The heat capacity of the components in the system (obtained from scientific literature).		
HS-PS3-4	In the investigation plan, students describe*: The data that will be collected, including masses of components and initial and final temperatures;	p. 20, ¶1	SB Content
HS-PS3-4	In the investigation plan, students describe*: The experimental procedure, including how the data will be collected, the number of trials, the experimental set up, and equipment required.	p. 20, ¶1	SB Content
HS-PS3-4	Students collect and record data that can be used to calculate the change in thermal energy of each of the two components of the system.	p. 20, ¶1	SB Content
Cross Cutting Concepts	**Patterns** ▪ Patterns are evident in the classifications on the periodic chart. Elements are classified by family, valence, electronegativity and metallic properties. ▪ Throughout Essential Chemistry calculations are approached using dimensional analysis. This approach uses a predictable and repeating pattern. ▪ Section and chapter review questions, lab work, and other assignments are designed to help students transition from recall to higher-level thinking. The questions were written to help students first organize information, then make connections between concepts. **Cause and Effect: Mechanism and Prediction** ▪ Scientific laws and Theories are used to make predictions about phenomenon. Students use Conservation laws, Charles', Boyle's, Ideal and Acid-Base definitions to determine unmeasured values. ▪ Guided simulations and lab activities give students the opportunity to witness cause-and-effect mechanisms on the visible scale as well as from the particle level perspective. These activities help students apply abstract concepts to new contexts and scenarios. **Scale, Proportion, and Quantity** ▪ Chemistry has an extreme range of scale. Atoms are incredibly small and to measure them there must be many present. Supporting assignments regularly ask students to think about how changing amounts of mass and energy on the particle level relates to the concept(s) currently under study. ▪ Proportion is evident in the use of balanced equations that are used with stoichiometric calculations throughout Essential Chemistry. ▪ Quantitative awareness in calculation and laboratory experiments is a theme throughout the text. Students may struggle with conceptualizing very large quantities, very small things, or how one measurement changes with respect to another. Essential Chemistry has many graphics, examples, analogies, and step-by-step solved problems to help students understand scale along with proportion and quantity.	N/A	

Systems and Systems Models

- Scientific Models are use make predictions about scientific phenomenon throughout Essential Chemistry. Examples are; the Kinetic Molecular Theory, the Valence Electron Shell Repulsion Theory and Quantum Mechanics. We have included visual diagrams to help students define a system and its boundary.

Energy and Matter: Flows Cycles, and Conservation

- Conservation of energy is a large theme in Essential Chemistry. Energy is used as a unifying theme to explain, phase changes, entropy, and the energetics of chemical reactions. Visual diagrams help students think about and keep track of energy as it moves between a system and its surroundings. The concept of energy flow is applied across a variety of scales from the atomic level to biogeochemical cycles.

Structure and Function

- Structure and function are illustrated by showing a molecules geometry effect its, polarity, solid structure, and boiling and freezing points.
- Atomic structure is used to explain charges on ions, reactivity, and periodic trends.

Stability and Change

- Conservations and Energetics are united in Essential Chemistry show molecular stability. They are also shown to motivate chemical change through reactions. Our lab activities and other assignments often require students to measure the rate of change. Students are asked to think about the implications of change on the system under study.

Science & Engineering Practices

The six Science and Engineering Practices are addressed in through our labs that lead to four capstone projects that employ design-redesign, cost analysis and project presentation. Each project asks students to design a solution to an everyday problem. Students are in charge of planning investigations which always include data collection, analysis, and interpretation within a defined set of constraints. Students must defend their decisions and propose explanations for outcomes. The projects are:

- Design an Insulator (Chapter 4)
- Design an Air Bag (Chapter 8)
- Design a Water Purification Project (Chapter 13)
- Design a Voltaic Cell (Chapter 18)

N/A