Community Unit School District 303
Chemistry

Performance Expectations	Disciplinary Core Ideas	Crosscutting Concepts	Science & Engineering Practices
HS-PS1-1. Matter and Its Interactions 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.	**PS1-A: Structure and Properties of Matter** Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons surrounded by electrons. The Periodic Table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns reflect patterns of the outer electron states. **PS2.B: Types of Interactions** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties and transformations of matter, as well as the contact forces between material objects.	**Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanation of phenomena.	**Developing and Using Models** Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

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HS-PS1-2. Matter and Its Interactions 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.	**PS1.A: Structure and Properties of Matter** The Periodic Table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns reflect patterns of the outer electron states. **PS1.B: Chemical Reactions** The fact that atoms are conserved together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.	**Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanation of phenomena.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
HS-PS1-3. Matter and Its Interactions 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.	**PS1.A: Structure and Properties of Matter** The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. **PS2.B: Types of Interactions** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.	**Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanation of phenomena.	**Planning and Carrying Out Investigations** Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

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HS-PS1-4. Matter and Its Interactions Develop a model to illustrate that the release or absorption or energy from a chemical reaction system depends upon the changes in total bond energy.	**PS1.A: Structure and Properties of Matter** A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. **PS1.B: Chemical Reactions** Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.	**Energy and Matter** Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.	**Developing and Using Models** Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

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HS-PS1-5. Matter and Its Interactions 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.	**PS1.B: Chemical Reactions** Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.	**Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanation of phenomena.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
HS-PS1-6. Matter and Its Interactions Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.	**PS1.B: Chemical Reactions** In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the number of all types of molecules present. **ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade offs) may be needed. .	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
HS-PS1-7. Matter and Its Interactions	**PS1.B: Chemical Reactions** The fact that atoms are	**Energy and Matter** The total amount of energy and	**Using Mathematics and Computational Thinking**

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Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.	matter in closed systems is conserved.	Mathematical and computational thinking at the 9-12 level builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
HS-PS2-6. Motion and Stability: Forces and Interactions Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.	**PS1.A: Structure and Properties of Matter** The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. **PS2.B: Types of Interactions** Attractions and repulsion between electric charges at the atomic scale explain the structure, property and transformations of matter, as well as the contact forces between material objects.	**Structure and Function** Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components to reveal its function and/or solve a problem.	**Obtaining, Evaluating and Communicating Information** Obtaining, evaluating, and communicating information in 9-12 builds on K-8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.
HS-PS3-4. Energy Plan and conduct an investigation to provide evidence that the	**PS3.B: Conservation of Energy and Energy Transfer** Energy cannot be created or	**Systems and System Models** When investigating or describing a system, the boundaries and	**Planning and Carrying Out Investigations** Planning and carrying out

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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).	destroyed, but it can be transported from one place to another and transferred between systems. Uncontrolled systems always evolve toward more stable states - that is, toward uniform energy distribution (e.g. water flows downhill, objects hotter than their surrounding environment cool down). **PS3.D: Energy in Chemical Processes** Although energy cannot be destroyed, it can be converted to less useful forms - for example, to thermal energy in the surrounding environment.	initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.	investigations to answer questions or test solutions to problems in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

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HS-ETS1-3. Engineering Design Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints.	**ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and to consider social, cultural and environmental impacts.	**Systems and System Models** Models (e.g., physical, mathematical, computer) can be used to simulate systems and interactions - including energy, matter, and information flows - within and between systems at different scales.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.