High School Chemistry
Essential Standards Extended Guide
HIGH SCHOOL CHEMISTRY

Background information about this document:

In response to requests from schools and districts for guidance on essential standards, committees of educators from around Idaho collaborated in the summer of 2024 to categorize Science standards into two groups:

1. **Essential standards** are explicitly taught, assessed multiple times, and receive targeted interventions for students who have not yet reached proficiency.
2. **Supporting standards** are taught to reinforce essential standards and may or may not be formally assessed.

This guidance helps LEAs prioritize the most critical standards, recognizing that not all standards are of equal importance. This document serves as a resource—not a mandate—to assist local efforts. Importantly, this work did not remove or revise any of the adopted Idaho Content Standards and is intended to refocus time and effort.

The committees developed instructional grouping models to demonstrate how standards can be combined into focused units. However, this is just one approach, and other combinations are possible. Educators can use this guide to begin developing scope and sequence for their instructional time and district-specific courses. It also provides a useful starting point for creating formative and summative assessments aligned with the standards.

Instructional Grouping 1: Atoms and Periodic Table

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSC-1.2 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.	Each atom has a substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PSC-1.2) 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 of this table reflect outermost electron states. (HS-PSC-1.2)
HS-PSC-1.4 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 the various modes of radioactive decay.	Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PSC-1.4)
HS-PSC-3.1 Students who demonstrate understanding can: Ask questions to clarify the idea that electromagnetic radiation can be described either by a wave model or a particle model.	Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PSC-3.1)

Note: This instructional grouping should include instruction about electron configuration, atomic structure, coulombic attraction, and periodic trends.

Further explanation:

1. 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.
2. 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.
3. Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include interference, diffraction, and photoelectric effect.

Assessment limits:

1. Assessment is limited to main group elements. Assessment is limited to relative trends in reactivity, valence electrons, atomic and ionic radius, electronegativity, ionization energy, shielding effect, and common oxidation number.

2. Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma modes of radioactive decay.
3. Assessment does not include using quantum theory.

Instructional Grouping 2: Bonding and Types of Matter

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSC-1.1 Develop models to describe the atomic composition of simple molecules and extended structures.	Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (HSPSC-1.1)
HS-PSC-1.3 Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrostatic forces between particles.	The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PSC-1.3, HS-PSC-1.5) Attraction and repulsion between electric charges at the atomic scale explain the structure, properties (physical and chemical), and transformations of matter, as well as the contact forces between material objects. (HS-PSC-1.3, HS-PSC-1.5, HS-PSP-1.6)
	Supporting Standard: HS-PSC-1.5 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Notes: This instructional grouping should include instruction about nomenclature, intermolecular forces, types of bonding, VSEPR models, ball-and-stick models, Lewis dot structures, molar mass, and percent composition.

Further explanation:

1. Emphasis is on reviewing how to develop models of molecules that vary in complexity. This should build on the similar middle school standard (MS-PS-1.1). Students should be able to determine valence electrons for representative elements. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of models could include drawings, 3D ball and stick structures, or computer representations.
2. Emphasis is on understanding the strengths of forces between particles. Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension

Assessment limits:

1. 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.

2. Assessment does not include naming specific intermolecular forces (such as dipole-dipole). Assessment will be limited to quantitative calculations of melting and boiling points only

Instructional Grouping 3: Chemical Reactions

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	Supporting Standards and Content **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSC-2.1 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.	The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar physical and chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PSC-2.1) 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. (HS-PSC-2.1, HSPSC-2.4)

Notes: This instructional grouping should include instruction about types of reactions (including acid-base reactions), solutions, molarity, pH, predicting products, and balancing equations.

Further explanation:

1. Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.

Assessment limits:

1. Assessment is limited to synthesis, decomposition, single replacement/displacement, double replacement/displacement—including neutralization—and combustion reactions. Predict the products of double replacement, single replacement, and combustion reactions only. Assessment excludes writing formulas or names of acids and hydrocarbons.

Instructional Grouping 4: Stoichiometry

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSC-2.4 Use mathematical representations to support the claim that the number and type of atoms, and therefore mass, are conserved during a chemical reaction.	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. (HS-PSC-2.1, HSPSC-2.4)

Notes: This instructional grouping should include instruction about molar conversions, stoichiometry, predicting reactions, limiting reagent, and percent yield.

Further explanation:

1. 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.

Assessment limits:

1. Conversion problems will be one to two steps (e.g., grams to moles to atoms/molecules). Compounds and formulas should be provided in the stem of the question. 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.

Instructional Grouping 5: Rates of Reactions

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSC-2.3 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.	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. (HS-PSC-2.2, HS-PSC-2.3)

Notes: This instructional grouping should include instruction about changes in reaction rates, energy diagrams, catalysts, and LeChatelier's Principle

Further explanation:

1. Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.

Assessment limits:

2. Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.

Instructional Grouping 6: Energy (Thermochemistry/Gas Laws

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSC-3.2 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.	Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PSC-3.2, HS-PSC-3.3) Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PSC-3.2) Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PSC-3.2, HS-PSC-3.5) Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PSC-3.2) The availability of energy limits what can occur in any system. (HS-PSC-3.2)
HS-PSC-3.5 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).	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PSC-3.2, HS-PSC-3.5) Uncontrolled systems always evolve toward more stable states—that is, toward a more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PSC-3.5) Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surroundings. (HS-PSC-3.4, HS-PSC-3.5)

	Supporting Standards: HS-PSC-2.2 Develop a model to illustrate that the energy transferred during an exothermic or endothermic chemical reaction is based on the bond energy difference between bonds broken (absorption of energy) and bonds formed (release of energy). HS-PSC-3.3 Students who demonstrate understanding can: 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). HS-PSC-3.4 Students who demonstrate understanding can: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Note: This instructional grouping should include instruction about kinetic molecular theory, energy diagrams, bond energies, enthalpy, specific heat, the relationship between pressure, volume and temperature (combined gas law), and the ideal gas law.

Further explanation:

1. Emphasis is on explaining the meaning of mathematical expressions used in the model.
2. Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually (endothermic/exothermic). Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.

Assessment limits:

1. Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields. Two temperatures (initial and final), a temperature-time graph, or an enthalpy diagram must be provided.
2. For items involving specific heat, provide the equation $Q = mCp\Delta T$ and specific heats. Include the melting and boiling points of water. Limit calculations to changes that do not involve a change of state. Perform gram to mole and mole to ΔH calculations. Use joules as a unit of measure, as opposed to calories.