K-12 Conceptual Vertical Articulation of PS1 – Matter and its Interactions

PS1.A: Structure and Properties of Matter

Grade Band	Disciplinary Core Idea Statement with 2021 Performance Expectation Linked
K–2	• Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1) • Different properties are suited to different purposes. (2-PS1-2) • Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces. (2-PS1-3)
3–5	• Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space (and can be detected by their impact on other objects) can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) • Measurements of a variety of properties can be used to identify materials. At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation. (5-PS1-3)
6–8	• Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (6-PS1-4) • 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. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (7-PS1-1) • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (7-PS1-2) (7-PS1-3)

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9–12	• 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 of this table reflect patterns of outer electron states. (C-PS1-1) • 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 patterns of outer electron states. (C-PS1-2) • The structure and interactions of matter at the broader level are determined by various forces within and between atoms. (C-PS1-3) (C-PS2-6) • 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. (C-PS1-4)

PS1.B: Chemical Reactions

Grade Band	Disciplinary Core Idea Statement with 2021 Performance Expectation Linked
K–2	• Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)
3–5	• No matter what reaction or change in properties occurs, the total weight of the substances does not change. (5-PS1-2) • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)
6–8	• Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (7-PS1-2) (7-PS1-3) • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. The total number of each type of atom is conserved, and thus the mass does not change. The total number of each atom is conserved, and thus the mass does not change. Some chemical reactions release energy, others store energy. (7-PS1-5) • Some chemical reactions release energy, others store energy. (7-PS1-6)
9–12	• 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. (C-PS1-2) (C-PS1-7) • The structure and interactions of matter at the broader level are determined by various forces within and between atoms. (C-PS1-3) • 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. (C-PS1-4) (C-PS1-5) • In many situations, a dynamic and condition- dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (C-PS1-6)

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PS1.C: Nuclear Processes

Grade Band	Disciplinary Core Idea Statement with 2021 Performance Expectation Linked
K–2	• PS1.C does not appear in any of the K-2 PEs.
3–5	• PS1.C does not appear in any of the 3-5 PEs.
6–8	• PS1.C does not appear in any of the 6-8 PEs.
9–12	• 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. (C-PS1-8) • Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials thereby fixing the scale of geological time. (secondary). (E-ESS1-6)

Adapted from *The Framework for K-12 Science Education* and the *Next Generation Science Standards.*

References:

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press.

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