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| **K.SPM Structure and Properties of Matter** |
| Students who demonstrate understanding can:  **a. Make observations that matter exists as different materials, which can be described and classified by their observable properties and their uses**. [Clarification Statement: Observable properties could include color, texture, and hardness.]  b. **Compare and share observations of solids and liquids at room temperature.**  c. **Plan and carry out investigations to test the idea that warming some materials causes them to change from solid to liquid and cooling causes them to change from liquid to solid. [**Clarification Statement: Students could investigate substances like butter, chocolate, ice, cheese, or ice cream. Students should be able to have the opportunity to see that not all substances’ phase changes with temperature.] [Assessment Boundary: Only a qualitative description of temperature should be used.]  d**. Distinguish between opinions and evidence in determining whether objects in a given set occur naturally or are manufactured.** [Clarification Statement: Examples of natural and manufactured objects could be a wooden dowel which has been made to be smooth and a tree limb which is not naturally smooth.]  e**. Ask questions and share information about the natural materials from which human-made products are built.** [Clarification Statement: Examples of natural and manufactured objects could be a wooden dowel which has been made to be smooth and a tree limb which is not naturally smooth.]   |  | | --- | | **2.SPM Structure, Properties, and Interactions of Matter** | | Students who demonstrate understanding can:  **a. Evaluate natural or designed objects to explain how the properties of the materials suit different purposes.** [Clarification Statement: Examples of materials could be hard turtle shell for protection, soft pillows for comfort.]  **b. Collaborate with others to design an object built from a small set of pieces to solve a technological problem.** [Clarification Statement: Examples of technological problems could be transporting or supporting an object with blocks or construction sets.]  **c. Provide evidence that some changes caused by heating or cooling can be reversed and some cannot.** [Clarification Statement: Examples of reversible changes could be melting chocolate or freezing liquids. Irreversible changes could be cooking food.]  **d. Measure and compare the physical properties of objects.** [Clarification Statement: Students will measure and compare weight and size of objects.] [Assessment Boundary: Mass and weight are not distinguished at this grade level.] | |

**NEXT GENERATION SCIENCE STANDARDS - MATTER**

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| **5. SPM Structure, Properties, and Interactions of Matter** |
| Students who demonstrate understanding can:  **a. Use the model that matter is made of particles too small to be seen to describe and explain everyday phenomena.** [Clarification Statement: Examples of everyday phenomena could be inflating a balloon, effect of air on large objects, or the smell of food cooking.]  **b. Investigate physical properties of materials and use the properties to distinguish one material from another.** [Clarification Statement: Examples of physical properties can include salt dissolving in water while sand does not; copper wire conducting electric current and shoelaces do not; a metal spoon conducting heat and a wooden spoon does not.]  **c. Investigate the interaction of two or more substances to provide evidence that when different substances are mixed, one or more new substances with different properties may or may not be formed depending on the substances and the temperature.** [Clarification Statement: Examples of interactions forming new substances can include mixing baking soda and vinegar. Examples of interactions not forming new substances can include mixing baking soda and water.]  **d. Plan and carry out investigations to determine the effect on the total weight of a substance when the substance changes shape, phase, and/or is dissolved.** [Assessment Boundary: No attempt should be made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.]  **e. Investigate and determine the effect on the total weight of matter when substances interact to form new substances.** [Clarification Statement: Examples of interacting substances can include putting wet steel wool in a closed container and letting it rust, and mixing vinegar and milk in a closed container.] [Assessment boundary: Mass and weight are not distinguished at this grade level.] |

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| **MS.PS-SPM Structure and Properties of Matter** |
| Students who demonstrate understanding can:  **a. Construct and use models to explain that atoms combine to form new substances of varying complexity in terms of the number of atoms and repeating subunits.** [Clarification Statement: Examples of atoms combining can include Hydrogen (H2) and Oxygen (O2) combining to form hydrogen peroxide (H2O2) or water (H2O).] [Assessment Boundary: Valence electrons and bonding energy are not addressed.]  **b. Plan investigations to generate evidence supporting the claim that one pure substance can be distinguished from another based on characteristic properties.** [Clarification Statement: Properties of substances can include melting and boiling points, density, solubility, reactivity, flammability, and phase.]  **c. Use a simulation or mechanical model to determine the effect on the temperature and motion of atoms and molecules of different substances when thermal energy is added to or removed from the substance.** [Assessment Boundary: Quantification of the model or use of mathematical formulas are not intended.]  **d. Construct an argument that explains the effect of adding or removing thermal energy to a pure substance in different phases and during a phase change in terms of atomic and molecular motion.** [Assessment Boundary: The use of mathematical formulas is not intended.] |

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| **MS.PS-CR Chemical Reactions** |
| Students who demonstrate understanding can:  **a. Develop representations showing how atoms regroup during chemical reactions to account for the conservation of mass.** [Assessment Boundary: Representations should not involve bonding energy or valence electrons. Balancing equations are also not employed here.]  **b. Generate and revise explanations from the comparison of the physical and chemical properties of reacting substances to the properties of new substances produced through chemical reactions to show that new properties have emerged.** [Assessment Boundary: Comparison and analysis should not involve statistical techniques.]  **c. Construct explanations of energy being released or absorbed when simpler molecules are combined into complex molecules or complex molecules are broken down to simpler molecules.** [Clarification Statement: Simple molecules can include H2O and CO2, and complex molecules can include C6H12O6 in photosynthesis.] [Assessment Boundary: Further details of the photosynthesis process are not addressed.]  **d. Develop models to represent the movement of matter and energy in the cycling of carbon.** [Clarification Statement: Examples of the movement of matter and energy could include the cycling from carbon in the atmosphere to carbon in living things.] [Assessment Boundary: Further details of the photosynthesis process are not addressed.] |

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| **HS.PS-SPM Structure and Properties of Matter** |
| Students who demonstrate understanding can:  **a. Construct models showing that stable forms of matter are those with minimum magnetic and electrical field energy.** [Clarification Statement: Examples of stable forms of matter can include noble gas atoms, simple molecules, and simple ionic substances.] [Assessment Boundary: Only for common substances- for example, water, carbon dioxide, common hydrocarbons, sodium chloride.]  **b. Construct various types of models showing that energy is needed to take molecules apart and that energy is released when the atoms come together to form new molecules.** [Assessment Boundary: Only for common substances (e.g., water, carbon dioxide, common hydrocarbons, sodium chloride]  **c. Develop explanations about how the patterns of electrons in the outer level of atoms, as represented in the periodic table, reflect and can predict properties of elements.** [Clarification Statement: An example of a pattern that predicts element properties is the first column of the periodic table: These elements all have one electron in the outer most energy level and as such are all highly reactive metals.] [Assessment Boundary: Only for main group elements (not transition metals or elements beyond the third row).]  **d. Construct arguments for which type of atomic and molecular representation best explains a given property of matter.** [Clarification Statement: Types of atomic and molecular representations can include computer-based, simulations, physical, ball and stick, and symbolic. Properties of matter can include reactivity, and polar vs. non-polar.] [Assessment Boundary: Not theoretical models]  **e. Analyze and interpret data obtained from measuring the bulk properties of various substances to explain the relative strength of the interactions among particles in the substance.** [Clarification Statement: Bulk properties of substances can include melting point and boiling point.] [Assessment Boundary: Comparisons between ionic and molecular species or network and molecular species are included, but those that require understanding of different intermolecular forces are not included. Only the following types of particles are included in data and explanations: atoms, ions, and molecules.] |

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| **HS.PS-CR Chemical Reactions** |
| Students who demonstrate understanding can:  **a. Analyze and interpret data to support claims that energy of molecular collisions and the concentration of the reacting particles affect the rate at which a reaction occurs.** [Assessment Boundary: Limited to simple (zero or first order in each reactant) reactions. The exact relationship between rate and temperature is not required.]  **b. Develop and use models to explain that atoms (and therefore mass) are conserved during a chemical reaction.** [Clarification Statement: Models can include computer models, ball and stick models, and drawings.] [Assessment Boundary: Stoichiometric calculations are not required.]  **c. Analyze and interpret data to make claims that reaction conditions can be used to optimize the output of a chemical process.** [Assessment Boundary: Limited to simple reactions. Reaction conditions are limited to temperature, pressure, and concentrations of all substances in the system.]  **d. Construct mathematical models to explain how energy changes in chemical reactions are caused by changes in binding energy as the reactants form products and in which changes in the kinetic energy of the system can be detected as change in temperature.** [Assessment Boundary: Limited to calculating the change in binding energy and resulting change in thermal energy for simple chemical reactions, (i.e., reactions of simple hydrocarbons with oxygen).]  **e. Construct and communicate explanations using the structure of atoms, trends in the periodic table and knowledge of the patterns of chemical properties to predict the outcome of simple chemical reactions.** [Assessment Boundary: Only those chemical reactions readily predictable from the element’s position on the periodic table and combustion reactions are intended.]  **f. Construct and communicate explanations that show how chemical processes and/or properties of materials are central to biological and geophysical systems.** [Clarification Statement: Chemical processes can include oxidation of hydrocarbons, and the reaction of CO2 and H20 to give hydrocarbons. Properties of materials can include water expanding when freezing.] [Assessment Boundary: Restricted to overall chemical processes (for example, oxidation of carbon compounds), or construction of carbon compounds (photosynthesis); details of biochemical pathways are not required (for example, Krebs Cycle).]  **g. Use system models (computer or drawings) to construct molecular-level explanations to predict the behavior of systems where a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.** [Assessment Boundary: Limited to simple reactions, adding or removing one reactant or product at a time.]  **h. Construct explanations using data from system models or simulations to support the claim that systems with many molecules have predictable behavior, but that the behavior of individual molecules is unpredictable.** |