NGSS OVERVIEW

CHEMISTRY OF MATERIALS

Performance Expectation MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures.

Performance Expectation MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Performance Expectation MS-PS1-4: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
1. **Talking It Over: Exploring Materials** Students begin to gather and synthesize information about the physical and chemical properties of three materials— glass, aluminum, and plastic. They assess how this information might be used as evidence for making a decision about which material to use for a drink container in relation to the structure and function of that object.	MS-PS1.A	Obtaining. Evaluating, and Communicating Information Asking Questions and Defining Problems Analyzing and Interpreting Data	Structure and Function Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World	ELA/Literacy: WHST.6-8.1
2. **Laboratory: Investigating Elements** Students carry out an investigation of the physical and chemical properties of a set of elements. They analyze and interpret the data they have collected on these elements, and begin to explore how this data can help identify pure substances. Finally, students synthesize what they have learned to further asses how this data can be used as evidence to determine if aluminum is a good choice for making a drink container.	MS-PS1.A	Obtaining. Evaluating, and Communicating Information Planning and Carrying Out Investigations Analyzing and Interpreting Data	Structure and Function Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World	ELA/Literacy: RST.6-8.3

CHEMISTRY OF MATERIALS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
3. **Laboratory: Physical and Chemical Properties of Materials** Students are introduced to compounds as well as chemical properties of materials. They conduct an investigation with several materials and use the data to determine how properties of a specific material would determine the use of the material, in particular, focusing on structure and function.	MS-PS1.A MS-PS1.B	Planning and Carrying Out Investigations Analyzing and Interpreting Data	Structure and Function Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology	ELA/Literacy: RST.6-8.3
4. **Laboratory: Determining Density** Students conduct an investigation to collect, analyze, and interpret data on density for several materials—aluminum, glass, and four types of plastics. Students connect their analysis of the densities of these materials to their possible uses, focusing on the crosscutting concept of structure and function.	MS-PS1.A	Planning and Carrying Out Investigations Analyzing and Interpreting Data Using Mathematics and Computational Thinking	Structure and Function Scale, Proportion, and Quantity	Mathematics: 7.RP.A.2
5. **Talking It Over: Evaluating Properties of Materials** Students read and synthesize information from multiple sources describing the use of materials and their potential impact on society. Students assess the credibility and possible bias of those sources. Students use this and additional information to inform a debate on which material would be best in terms of the structure and function of its intended purpose (as a reusable drink container) and in terms of impact on society.	MS-PS1.A	Obtaining. Evaluating, and Communicating Information Asking Questions and Defining Problems	Structure and Function Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World	
6. **Modeling: Modeling Molecules** Students are introduced to the practice of modeling as a tool to investigate phenomena at a molecular scale. Students use models to investigate the atomic composition of simple molecules and compounds.	MS-PS1.A	Developing and Using Models	Scale, Proportion, and Quantity	

CHEMISTRY OF MATERIALS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
7. **Reading: Structure and Properties of Materials** Students obtain information from text and diagrams of structural models to elaborate on what students observed when they developed models of molecules and extended structures in the previous activity. This activity emphasizes the crosscutting concept of scale, quantity, and proportion as students observe the varieties of particles that make up substances. The activity also focuses on structure and function, building the concept that the particle structure of a substance determines its bulk properties and the ways that the substance can be used.	MS-PS1.A	Developing and Using Models Obtaining, Evaluating, and Communicating Information	Scale, Proportion, and Quantity Structure and Function	ELA/Literacy: RST.6-8.2 RST.6-8.7
8. **Talking It Over: What's in a State?** Students begin their investigations about the three states of matter. Students make observations and construct explanations about how the behavior of the particles in each state causes the observable properties of solids, liquids, and gases. Students then use a computer simulation to gather more information to begin developing models of the particles in solids, liquids, and gases.	MS-PS1.A	Developing and Using Models Constructing Explanations and Designing Solutions	Cause and Effect	
9. **Laboratory: Energy and Particle Movement** Students carry out investigations to collect data about how temperature and kinetic energy relate to gas particles. Students investigate cause-and-effect relationships between adding and removing thermal energy to raise or lower temperature and the movement of gas particles. They use their new understandings to further refine their models about particles in different states to include kinetic energy.	MS-PS1.A MS-PS3.A	Developing and Using Models Planning and Carrying Out Investigations Engaging in Argument from Evidence	Cause and Effect	
10. **Laboratory: Modeling State Changes** Students carry out an investigation to collect data about the relationships between temperature and state changes. They analyze and interpret these data in order to construct explanations about what is happening to particles during state changes. Students further develop their models that depict particle movement, temperature, and state, including the role of thermal energy. This activity provides an opportunity to assess Performance Expectation MS-PS1-4.	MS-PS1.A MS-PS3.A	Developing and Using Models Planning and Carrying Out Investigations Analyzing and Interpreting Data Constructing Explanations and Designing Solutions	Cause and Effect	ELA/Literacy: RST.6-8.3

CHEMISTRY OF MATERIALS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
11. **Laboratory: Making Polymers** Students conduct an investigation in which they cross-link a polymer and analyze the results by comparing the starting and final substances. This reinforces the characteristic properties of each pure substance while introducing chemical change. The crosscutting concepts of structure and function, and connections to engineering, technology, and applications of science are related to the design and impact of engineered products.	MS-PS1.A MS-PS1.B	Planning and Carrying Out Investigations Analyzing and Interpreting Data Obtaining. Evaluating, and Communicating Information	Structure and Function Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World	ELA/Literacy: RST.6-8.3
12. **Modeling: Modeling Polymers** Students use structural models at various scales explain and predict the properties of plastics. This activity draws together the core ideas related to structure and properties of matter and the crosscutting concepts of structure and function, and scale, proportion, and quantity through the practice of modeling. The activity provides an opportunity to assess Performance Expectation MS-PS1-1.	MS-PS1.A MS-PS1.B	Developing and Using Models	Structure and Function Scale, Proportion, and Quantity Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World	ELA/Literacy: WHST.6-8.9

CHEMISTRY OF MATERIALS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
13. **Talking It Over: The Impact of Plastics on Society** Students gather, read, and synthesize information from text and diagrams about four types of polymers (Teflon, Kevlar, compostable polymers, and polyester). Students apply this information to an analysis of the impact of these materials on society, focusing on the crosscutting concepts of structure and function and connections to engineering, technology, and applications of science. This activity provides an opportunity to assess Performance Expectation MS-PS1-3.	MS-PS1.A	Obtaining, Evaluating, and Communicating Information Constructing Explanations and Designing Solutions	Structure and Function Connections to Engineering, Technology, and Applications of Science	ELA/Literacy: RST.6-8.7 WHST.6-8.1 WHST.6-8.9

CHEMISTRY OF MATERIALS

Unit Issue: Properties of materials determine their uses and effect on the environment.

Anchoring Phenomenon: Different materials are used for different purposes. Examples explored include properties of plastic, glass, and metal drink containers and water bottles, and the varied properties and uses of plastics in thousands of everyday objects. Students generate and answer questions such as: How do the particle structures of materials vary? How do these structures determine the properties of materials? How do the properties of materials affect their usefulness and impact on the environment?

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
Materials like plastics, metals, and glass are all useful, but they can also affect the environment.	How do a material's properties affect its uses?	What information would help you decide which material is best for making a single- use drink container? (Activity 1)	1, 2, 3, 4, 5	MS-PS1-3	Materials for drink containers introduce the properties, production, and wastes for three materials, and introduce advantages and disadvantages of using materials for various purposes.
		How can scientists use physical properties to identify elements? (Activity 2)			All materials are made from a limited number of elements (each having characteristic properties and atoms).
		How do the properties of materials determine their uses? (Activity 3)			Properties such as color, solubility, density, and melting and boiling point determine the uses of materials.
		How can you use the mass and volume of an object to calculate its density? (Activity 4)			A substance's density can be calculated and used both to identify substances and to select substances for various uses.
		How can information be evaluated for bias? (Activity 5)			Although Web resources may have points of view and biases, it is possible to obtain information about the resources used to make materials, the advantages of these materials for solving problems, and the impact of these materials on society.

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

CHEMISTRY OF MATERIALS (continued)

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
Even though we can't see atoms, they make up all the stuff around us.	Why do materials have unique properties?	How do atoms combine to form molecules? (Activity 6)	6, 7	MS-PS1-1	Substances have specific structures that can be modeled by arranging atomic models in various ways.
		How do the structures of particles in substances vary? (Activity 7)			A closer look at particles explains more properties, such as density and solubility.
Some substances, such as water, can exist as a solid, liquid, or gas.	What happens to the particles in a substance as it changes temperature or changes from one state to another?	How does the particle structure of matter explain the differences between solids, liquids, and gases? (Activity 8)	8, 9, 10	MS-PS1-4	At room temperature, some substances are solid while others are liquid or gas. Particle models, including models of the distances between particles and their motions, help explain the differences between the states of matter.
		What happens when gas particles are heated or cooled? (Activity 9)			Particle motion also helps explain the properties of a substance as temperature changes. Increased temperature indicates increased particle motion (kinetic energy). Decreased temperature indicates decreased particle motion (kinetic energy).
		What happens to the particles and temperature of a substance as it changes state? (Activity 10)			Transfer of thermal energy to a substance increases the substance's average kinetic energy (temperature) except during a change of state.

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

CHEMISTRY OF MATERIALS (continued)

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
Materials like plastics, metals, and glass are all useful, but they can also affect the environment.	How do a material's properties affect its uses?	How are plastics engineered for various uses? (Activity 11)	11, 12, 13	MS-PS1-3 MS-PS1-1	Plastics are synthetic materials that can be designed with a variety of structures and functions.
		How do the structures of plastics relate to their varied properties? (Activity 12)			The structure of a plastic causes it to have specific properties that allow plastics to be engineered to have a wide range of properties and, thus, uses.
		What are the benefits and trade-offs of different plastics? (Activity 13)			Synthetic materials, such as plastics, are made from natural resources and have many impacts, both positive and negative, on human health and the environment.

NGSS CORRELATIONS

CHEMISTRY OF MATERIALS

Crosscutting Concepts		Activity number
Cause and Effect	Cause and effect relationships may be used to predict phenomena in natural or designed systems.	8, 9, 10
Structure and Function	Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.	7
	Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.	1, 2, 3, 4, 5, 11, 12, 13
Scale, Proportion, and Quantity	Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.	6, 7, 12
	Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.	4
	Scientific relationships can be represented through the use of algebraic expressions and equations.	4
Connections to Engineering, Technology, and Applications of Science	Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems	1, 2, 3, 5, 11, 13
	The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time.	
Science and Engineering Practices		**Activity number**
Analyzing and Interpreting Data	Analyze and interpret data to determine similarities and differences in findings.	1, 2, 3, 4, 11
	Analyze and interpret data to provide evidence for phenomena.	10
Asking Questions and Defining Problems	Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.	1
	Ask questions to identify and clarify evidence of an argument.	
	Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.	5

Science and Engineering Practices		Activity number
Constructing Explanations and Designing Solutions	Construct an explanation that includes qualitative or quantitative relationships between variables that predict or describe phenomena.	8, 10
	Apply scientific ideas to construct an explanation for real world phenomena, examples, or events.	13
Developing and Using Models	Develop a model to predict and/or describe phenomena.	6, 7, 8, 9, 10, 12
	Develop a model to describe unobservable mechanisms.	6, 8, 9, 10, 12
	Evaluate limitations of a model for a proposed object or tool.	12
Engaging in Argument from Evidence	Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon.	9
Obtaining, Evaluating, and Communicating Information	Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.	5, 7
	Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.	1, 2, 5, 11, 13
Planning and Carrying Out Investigations	Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.	2, 3, 4, 9, 10, 11
Using Mathematics and Computational Thinking	Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.	4
Disciplinary Core Ideas		**Activity number**
Structure and Properties of Matter (PS1.A)	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.	2, 6, 7, 11, 12
	Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.	1, 2, 3, 4, 5, 11, 12, 13
	Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.	8, 9, 10
	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.	8, 9, 10
	Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).	6, 7, 11, 12
	The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.	9, 10

Disciplinary Core Ideas		Activity number
Chemical Reactions (PS1.B)	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.	3, 11, 12
Definitions of Energy (PS3.A)	The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.	9, 10
	The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material.	8, 9, 10
Performance Expectations		**Activity number**
Matter and Its Interactions (PS1)	Develop models to describe the atomic composition of simple molecules and extended structures. (MS-PS1-1)	12
	Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. (MS-PS1-3)	13
	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. (MS-PS1-4)	10

COMMON CORE STATE STANDARDS: CONNECTIONS AND CORRELATIONS

CHEMISTRY OF MATERIALS

Making Connections in ELA

As with all SEPUP instructional materials, this unit introduces multiple opportunities for students to engage in a range of ELA practices and skills that are important grade-specific goals of the common core state standards and are also essential to the sensemaking students are doing throughout the unit. Specifically, the unit provides multiple opportunities for students to obtain, evaluate and communicate information as it relates to chemistry concepts. Students begin and end the unit developing written arguments focused on evidence related to physical and chemical properties of materials in relation to choosing a material for a specific function (WHST.6-8.1). As students progress through the unit, they engage in a number of experiments (Activities 2, 3, 10, and 11) which require them to follow multi-step procedures (RST.6-8.3) and the data they gather helps them engage in sense-making and build their understanding of the chemistry concepts being investigated. Activity 7 offers an in-depth reading on the structure and properties of materials. As students engage with the reading, they integrate technical information from the text with diagrams in the reading, as well as with physical models they explored in previous activities (RST.6-8.7). Students also collaboratively discuss and come to consensus on the central ideas in the text (RST.6-8.2), relating them to the concept of scale, proportion, and quantity and how this information relates to what they have investigated in previous activities. In the final activity of the unit, students synthesize their understanding of chemistry concepts related to various materials by integrating technical information from text with diagrams in a reading as well as with models, diagrams, and other visual representations from previous activities (RST.6-8.7). They draw on this evidence to support their analysis of the impact of the use of various materials (different plastics) on society (WHST.6-8.9) and use that analysis to develop an oral and written argument to support a particular recommendation around the use of plastics in a community (WHST.6-8.1). Specific literacy strategies are embedded throughout the unit to support student development of particular ELA skills and practices. In addition, appendix E in the Student Book contains optional resources to support reading, writing and oral communication.

Common Core State Standards – English Language Arts		Activity number
Reading in Science and Technical Subjects (RST)	Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (RST.6-8.2)	7
	Follow precisely a multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks. (RST.6-8.3)	2, 3, 10, 11
	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (RST.6-8.7)	7, 13
Writing in History/ Social Studies, Science, and Technological Subjects (WHST)	Write arguments focused on discipline-specific content. (WHST.6-8.1)	1, 13
	Draw evidence from informational texts to support analysis, reflection, and research. (WHST.6-8.9)	13

Making Connections in Mathematics

This unit introduces an opportunity for students to engage in an important grade-specific concept of the common core state standards. Specifically, in Activity 4 students use proportional relationships to investigate density in different materials. They use this mathematical reasoning concept to make predictions, perform calculations, and test their predictions experimentally as they explore density through the proportional relationship between mass and volume, providing them with the opportunity to recognize and represent proportional relationships (7.RP.A.2).

Common Core State Standards – Mathematics		Activity number
Ratios and Proportional Reasoning (RP)	Recognize and represent proportional relationships between quantities. (7.RP.A.2)	4