### MS-PS1 Matter and Its Interactions

Students who demonstrate understanding can:

**MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.** [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations of showing different molecules or different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]

**MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.** [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]

**MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.** [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]

**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.** [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]

**MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.** [Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]

**MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*[Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]

The performance expectations above were developed using the following elements from the NRC document _A Framework for K-12 Science Education._

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### Science and Engineering Practices

**Developing and Using Models**  
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop a model to predict and/or describe phenomena.  
  (MS-PS1-1), (MS-PS1-4)
- Develop a model to describe unobservable mechanisms.  
  (MS-PS1-5)

**Analyzing and Interpreting Data**  
Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- Analyze and interpret data to determine similarities and differences in findings.  
  (MS-PS1-2)

**Constructing Explanations and Designing Solutions**  
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations or designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.  
  (MS-PS1-6)

**Obtaining, Evaluating, and Communicating Information**  
Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods.
- 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.  
  (MS-PS1-3)

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### Disciplinary Core Ideas

**PS1.A: Structure and Properties of Matter**
- 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.  
  (MS-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.  
  (MS-PS1-2), (MS-PS1-3)
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.  
  (MS-PS1-4)
- In a liquid, the molecules are constantly in contact with one another; 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.  
  (MS-PS1-4)
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).  
  (MS-PS1-1)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.  
  (MS-PS1-4)

**PS1.B: Chemical Reactions**
- 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.  
  (MS-PS1-2), (MS-PS1-3), (MS-PS1-5)
- The total number of each type of atom is conserved, and thus the mass does not change.  
  (MS-PS1-5)
- Some chemical reactions release energy, others store energy.  
  (MS-PS1-6)

**PS3.A: Definitions of Energy**
- 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 denotes the energy transferred due to the temperature difference between two objects.  
  (secondary to MS-PS1-4)
- 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 internal energy) of a system depends...
# MS-PS1 Matter and Its Interactions

## Science Models, Laws, Mechanisms, and Theories

**Explain Natural Phenomena**
- Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5)

## RST.6 Matter and Its Interactions

- Know or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (secondary to MS-PS1-6)
- Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS1-6)
- Develop possible solutions and modify them to improve their effectiveness; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-PS1-3)
- Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS1-2), (MS-PS1-3)
- Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS1-6)
- 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). (MS-PS1-1), (MS-PS1-2), (MS-PS1-4), (MS-PS1-5)

## WHST.6 Literacy and Technical Communication

- Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-2), (MS-PS1-5)
- Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-PS1-4)
- Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. (MS-PS1-1)
- Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (MS-PS1-2)
- Summarize numerical data sets in relation to their context (MS-PS1-2)

## Mathematics

- Reason abstractly and quantitatively. (MS-PS1-1), (MS-PS1-2), (MS-PS1-5)
- Model with mathematics. (MS-PS1-1), (MS-PS1-5)
- Model with mathematics. (MS-PS1-1), (MS-PS1-5)

## ELA/Literacy

- Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS1-2), (MS-PS1-3)
- Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS1-6)
- 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). (MS-PS1-1), (MS-PS1-2), (MS-PS1-4), (MS-PS1-5)

## Articulation across grade bands:

- **PS1** (MS-PS1-1), (MS-PS1-2), (MS-PS1-5); **ESS2** (MS-PS1-1), (MS-PS1-2), (MS-PS1-5); **ESS3** (MS-PS1-1), (MS-PS1-2), (MS-PS1-5)

## Connections to other DCIs in this grade-band:

- **MS.LS2.1** (MS-PS1-2), (MS-PS1-6); **MS.LS2.2** (MS-PS1-3); **RST.6** (MS-PS1-1)

## Common Core State Standards Connections:

<table>
<thead>
<tr>
<th>ELA/Literacy</th>
<th>Mathematics</th>
<th>Science Models, Laws, Mechanisms, and Theories</th>
</tr>
</thead>
<tbody>
<tr>
<td>RST.6-8.1</td>
<td>Reason abstractly and quantitatively. (MS-PS1-1), (MS-PS1-2), (MS-PS1-5)</td>
<td>Explain Natural Phenomena</td>
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<tr>
<td>RST.6-8.3</td>
<td>Model with mathematics. (MS-PS1-1), (MS-PS1-5)</td>
<td>Explain Natural Phenomena</td>
</tr>
<tr>
<td>RST.6-8.7</td>
<td>Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-2), (MS-PS1-5)</td>
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<tr>
<td>WHST.6-8.7</td>
<td>Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-PS1-4)</td>
<td>Explain Natural Phenomena</td>
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<td>6.RP.A.3</td>
<td>Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. (MS-PS1-1)</td>
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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

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