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 particulate-level models could include drawings, 3D ball and stick structures, or computer representations showing different substances with different types of atoms.) [ Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the individual ions composing complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]

**MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural and human design processes.**

( 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 the qualitative interpretation of evidence provided.]

**MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and phase (state) of a substance when thermal energy is added or removed.**

( Clarification Statement: Emphasis is on qualitative particulate-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 phase occurs. Examples of models could include drawings and diagrams. Examples of particles could include ions, molecules, or atoms. Examples of substances could include sodium chloride, water, carbon dioxide, and helium.]

**MS-PS1-7. Use evidence to illustrate that density is a property that can be used to identify samples of matter.**

( Clarification Statement: Emphasis should be on students measuring the masses and volumes of regular and irregular shaped objects, calculating their densities, and identifying the samples by density.]

**MS-PS1-8. Plan and conduct an investigation to demonstrate that mixtures are combinations of substances.**

( Clarification Statement: Emphasis should be on analyzing the physical changes that occur as mixtures are formed and/or separated. Examples of common mixtures could include salt water, oil and vinegar, and air.) [Assessment Boundary: Assessment is limited to separation by evaporation, filtration and magnetism.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas* unless it is preceded by (NYSED).

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### Science and Engineering Practices

**Developing and Using Models**

- Modeling in 6–8 builds on K–5 and progress 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)

**Planning and Carrying Out Investigations**

- Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.
  - Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS1-8)
  - Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-PS1-8)

**Engineering in Argument from Evidence**

- Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.
  - Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-PS1-7)

### Disciplinary Core Ideas

#### PS1: Structure and Properties of Matter

- **(NYSED) Substances are made of one type of atom or combinations of different types of atoms.**
  - Individual atoms are identical and can be combined to form larger particles that range in size from two to thousands of atoms. (MS-PS1-1)
  - Each substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-2.)

- **(NYSED) In a solid, the particles are closely spaced and vibrate in position but do not change their relative locations. In a liquid, the particles are closely spaced but are able to change their relative locations. In a gas, the particles are widely spaced except when they happen to collide and constantly change their relative locations. (MS-PS1-4)**

- **(NYSED) Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)**

- **(NYSED) The changes of state that occur with variations in temperature and/or pressure can be described and predicted using these models of matter. (MS-PS1-4)**

- **(NYSED) Mixtures are physical combinations of one or more samples of matter and can be separated by physical means. (MS-PS1-4)**

#### PS1-B: Chemical Reactions

- **(NYSED) Substances react chemically in characteristic ways.**
  - In a chemical process, the atoms that make up the original substances are regrouped into different particles, and these new substances have different properties from those of the reactants. (MS-PS1-3) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-2 and MS-PS1-5.)

#### PS3: Definitions of Energy

- **(NYSED) The term “heat” as used in everyday language refers both to thermal energy (the motion of particles within a substance) and the transfer of that thermal energy from one 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. (secondary to MS-PS1-4)**

- **(NYSED) Temperature is not a form of energy. Temperature is a measurement of the average kinetic energy of the particles in a sample of matter. (secondary to MS-PS1-4)**

### Crosscutting Concepts

#### Patterns

- Microscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-1), (MS-PS1-7), (MS-PS1-8)
  - Graphs, charts, and images can be used to identify patterns in data. (MS-PS1-1), (MS-PS1-4)

#### Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

#### 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. (MS-PS1-1)

### Connections to Other Disciplinary Core Ideas (DCIs)

#### Interdependence of Science, Engineering, and Technology

- 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. (MS-PS1-3)

#### Influence of Science, Engineering, and Technology on Society and the Natural World

- The uses 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. (MS-PS1-3)

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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The text in the “Disciplinary Core Ideas” section is reproduced verbatim from *A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas* unless it is preceded by (NYSED).
**New York State Next Generation Learning Standards Connections**

**ELA/Literacy**

| 6-8RST1 | Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-PS1-3) |
| 6-8RST7 | Identify and match scientific or technical information presented as text with a version of that information presented visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS1-1),(MS-PS1-4) |
| 6-8WHST.8 | Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source by applying discipline specific criteria used in the social sciences or sciences; and quote or paraphrase the data/accounts and conclusions of others while avoiding plagiarism and following a standard format for citation or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-PS1-3), (MS-PS1-7) |

**Mathematics**

| MP.2 | Reason abstractly and quantitatively. (MS-PS1-1), (MS-PS1-8) |
| MP.4 | Model with mathematics. (MS-PS1-1) |
| NY-6.RP.4 | Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-1),(MS-PS1-7) |
| NY-6.NS.5 | Understand that positive and negative numbers are used together to describe quantities having opposite directions or values. Use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-PS1-4) |
| NY-8.EE.3 | 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) |

*Connection boxes updated as of September 2018*

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**Science and Engineering Practices**

<table>
<thead>
<tr>
<th>Developing and Using Models</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
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<td>PS1.A: Structure and Properties of Matter</td>
<td>Patterns</td>
</tr>
<tr>
<td>Analyzing and Interpreting Data</td>
<td>• (NYSED) Each substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)</td>
<td>• Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)</td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>PS1.B: Chemical Reactions</td>
<td>Energy and Matter</td>
</tr>
<tr>
<td>Constructing explanations and designing solutions in 6-8 builds on K-5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.</td>
<td>• (NYSED) Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different particles and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-5) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)</td>
<td>• Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5)</td>
</tr>
<tr>
<td>• 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)</td>
<td>• The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)</td>
<td>• The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)</td>
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</tbody>
</table>

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**Connections to Nature of Science**

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<tr>
<th></th>
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<th></th>
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</thead>
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<td>• Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS1-2)</td>
<td>• (NYSED) Each substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)</td>
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<td>• Laws are regularties or mathematical descriptions of natural phenomena. (MS-PS1-5)</td>
<td>• (NYSED) Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different particles and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-5) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)</td>
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<td>Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5)</td>
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<tr>
<td>• Chemical Reactions</td>
<td>• (NYSED) Some chemical reactions release energy, others absorb energy. (MS-PS1-6)</td>
<td>• The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)</td>
</tr>
</tbody>
</table>

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**Connections to other DCS in this grade-band**

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MS.PS1-D</td>
<td>MS.PS1-2</td>
<td>MS.PS1-6</td>
<td>MS.PS1-2</td>
<td>MS.PS1-2</td>
<td>MS.PS1-5</td>
<td>MS.PS1-5</td>
<td>MS.PS1-2</td>
<td>MS.PS1-6</td>
</tr>
</tbody>
</table>

**Articulation of DCS across grade-bands**

<table>
<thead>
<tr>
<th>5.PS1.B</th>
<th>MS.PS1-2</th>
<th>MS.PS1-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS.PS1.A</td>
<td>MS.PS1-6</td>
<td>MS.PS1-5</td>
</tr>
<tr>
<td>MS.PS1.B</td>
<td>MS.PS1-2</td>
<td>MS.PS1-5</td>
</tr>
<tr>
<td>MS.PS1.C</td>
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</tr>
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<td>MS.PS1-2</td>
<td>MS.PS1-5</td>
</tr>
</tbody>
</table>

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**New York State Next Generation Learning Standards Connections**

<table>
<thead>
<tr>
<th>ELA/Literacy</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-8.RST.1</td>
<td>MP.2</td>
</tr>
<tr>
<td>6-8.RST.7</td>
<td>MP.4</td>
</tr>
<tr>
<td>6-8.WHST.7</td>
<td>NY-6.RP.3</td>
</tr>
<tr>
<td></td>
<td>NY-6.SP.4</td>
</tr>
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The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*.
# New York State P-12 Science Learning Standards

## New York State Next Generation Learning Standards Connections:

**ELA/Literacy -**

**6-8.RST.1**  
Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-PS-2-1),(MS-PS2-3)

**6-8.WHST.1**  
Write arguments based on discipline-specific content. (MS-PS2-4)

**6-8.WHST.7**  
Conduct short research projects to answer a question (including a self-generated question by the end of grade 8), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS2-1),(MS-PS2-2),(MS-PS2-5)

**Mathematics -**

**MP.2**  
Reason abstractly and quantitatively. (MS-PS2-1),(MS-PS2-2),(MS-PS2-3)

**NY-6.NS.5**  
Understand that positive and negative numbers are used together to describe quantities having opposite directions or values. Use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-PS2-1)

**NY-6.EE.2**  
Write, read, and evaluate expressions in which letters stand for numbers. (MS-PS2-1),(MS-PS2-2)

**NY-7.EE.3**  
Solve multi-step real-world and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate. Assess the reasonableness of answers using mental computation and estimation strategies. (MS-PS2-1),(MS-PS2-2)

**NY-7.EE.4**  
Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-PS2-1),(MS-PS2-2)

*Connection boxes updated as of September 2018*

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Students who demonstrate understanding can:

**MS-PS3-1.** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.  
[Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.] 
[Assessment Boundary: Assessment could include both qualitative and quantitative explanations or solutions about the natural and designed worlds.]

**MS-PS3-2.** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.  
[Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate’s hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] 
[Assessment Boundary: Assessment is limited to two objects and electromagnetic and gravitational interactions.]

**MS-PS3-3.** Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*  
[Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] 
[Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

**MS-PS3-4.** Plan and conduct an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the temperature of the sample of matter.  
[Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] 
[Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

**MS-PS3-5.** Construct, use, and present an argument to support the claim that when work is done on or by a system, the energy of the system changes as energy is transferred to or from the system.  
[Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] 
[Assessment Boundary: Assessment could include calculations of work and energy.]

**MS-PS3-6.** Make observations to provide evidence that energy can be transferred by electric currents.  
[Clarification Statement: Emphasis should be on arrangements of circuit components in series and parallel circuits.] 
[Assessment Boundary: Assessment will be limited to qualitative analysis and reasoning.]

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</tr>
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<td>Developing and Using Models</td>
<td>PS3.A: Definitions of Energy</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>• Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)</td>
<td></td>
</tr>
<tr>
<td>• Develop a model to describe unobservable mechanisms. (MS-PS3-2)</td>
<td>• A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)</td>
<td></td>
</tr>
<tr>
<td>Planning and Carrying Out Investigations</td>
<td>• (NYSED) Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, phases (states), and amounts of matter present. (MS-PS3-3),(MS-PS3-4)</td>
<td></td>
</tr>
<tr>
<td>Planning and carrying out investigations to answer questions or test solutions to problems in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions under a range of conditions. (MS-PS3-6)</td>
<td>• When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)</td>
<td></td>
</tr>
<tr>
<td>Analyzing and Interpreting Data</td>
<td>• (NYSED) The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the mass of the sample, and the environment. (MS-PS3-4)</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>• Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)</td>
<td></td>
</tr>
<tr>
<td>• Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)</td>
<td>• (NYSED) An electric circuit is a closed path in which an electric current can exist. (MS-PS3-6)</td>
<td></td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>PS3.B: Conservation of Energy and Energy Transfer</td>
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<tr>
<td>Constructing explanations and designing solutions in 6-8 builds on K-5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</td>
<td>• When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)</td>
<td></td>
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<tr>
<td>• Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3)</td>
<td>ETS1.A: Defining and Delimiting an Engineering Problem</td>
<td></td>
</tr>
<tr>
<td>Engaging in Argument from Evidence</td>
<td>• The more precisely a design task’s criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to MS-PS3-3)</td>
<td></td>
</tr>
<tr>
<td>Engaging in argument from evidence in 6-8 builds on K-5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed worlds.</td>
<td>ETS1.B: Developing Possible Solutions</td>
<td></td>
</tr>
<tr>
<td>• Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning</td>
<td>• A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to MS-PS3-3)</td>
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**New York State P-12 Science Learning Standards**

### Connections to Nature of Science

**Scientific Knowledge is Based on Empirical Evidence**
- Science knowledge is based upon logical and conceptual connections between evidence and explanations (MS-PS3-4), (MS-PS3-5)

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**Connections to other DCIs in this grade-band**
- MS.PS1.A (MS-PS3-4); MS.PS1.B (MS-PS3-3); MS.PS2.A (MS-PS3-1), (MS-PS3-4), (MS-PS3-5); MS.ESS2.A (MS-PS3-3); MS.ESS2.C (MS-PS3-3), (MS-PS3-4); MS.ESS2.D (MS-PS3-3), (MS-PS3-4); MS.ESS3.D (MS-PS3-4)

**Articulation of DCIs across grade-bands:**
- 4.PS3.B (MS-PS3-1), (MS-PS3-3); 4.PS3.C (MS-PS3-4), (MS-PS3-5); HS.PS1.B (MS-PS3-4); HS.PS2.B (MS-PS3-2); HS.PS3.A (MS-PS3-1), (MS-PS3-4), (MS-PS3-5); HS.PS3.B (MS-PS3-1), (MS-PS3-2), (MS-PS3-3), (MS-PS3-4), (MS-PS3-5); HS.PS3.C (MS-PS3-2)

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**New York State Next Generation Learning Standards**

**Connections: ELA/Literacy –**
- 6-8.RST.1 Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-PS3-1), (MS-PS3-5), (MS-PS3-6)
- 6-8.RST.7 Identify and match scientific or technical information presented as text with a version of that information presented visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1)
- 6-8.WHST.1 Write arguments based on discipline-specific content. (MS-PS3-5)
- 6-8.WHST.7 Conduct short research projects to answer a question (including a self-generated question by the end of grade 8), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS3-3), (MS-PS3-4)
- 8.SL.5 Integrate digital media and/or visual displays in presentations to clarify information, strengthen claims and evidence, and add elements of interest to engage the audience. (MS-PS3-2)

**Mathematics –**
- MP.2 Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5), (MS-PS3-6)
- NY-6.RP.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-1), (MS-PS3-5), (MS-PS3-6)
- NY-6.RP.2 Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship. (MS-PS3-1)
- NY-7.RP.2 Recognize and represent proportional relationships between quantities. (MS-PS3-1), (MS-PS3-5)
- NY-8.EE.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)
- NY-8.EE.2 Use square root and cube root symbols to represent solutions to equations of the form x² = p and x³ = p, where p is a positive rational number. Know square roots of perfect squares up to 225 and cube roots of small perfect cubes up to 125. Know that the square root of a non-perfect square is irrational. (MS-PS3-1)
- NY-8.F.3 Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line. Recognize give examples of functions that are linear and not linear. (MS-PS3-1), (MSPS3-5)
- NY-6.SP.5 Summarize quantitative data sets in relation to their context. (MS-PS3-4)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The text in the “Disciplinary Core Ideas” section is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas unless it is preceded by (NYSED).*
New York State P-12 Science Learning Standards

MS. Waves and Electromagnetic Radiation

**MS-PS4-1.** Develop a model and use mathematical representations to describe waves that includes frequency, wavelength, and how the amplitude of a wave is related to the energy in a wave. [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [Assessment Boundary: Assessment is limited to comparing standard repeating waves of only one type (transverse or longitudinal).]

**MS-PS4-2.** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, ray diagrams, simulations, and written descriptions. Materials could include plane, convex, and concave mirrors and biconvex and biconcave lenses.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]

**MS-PS4-3.** Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. [Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]

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

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 describe phenomena. (MS-LS1-2)

**Planning and Carrying Out Investigations**
Planning and carrying out investigations in 6-8 builds on K5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.
- Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. (MS-LS1-1)

**Constructing Explanations and Designing Solutions**
Constructing explanations and designing solutions in 6-8 builds on K-5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-3)

**Obtaining, Evaluating, and Communicating Information**
Obtaining, evaluating, and communicating information in 6-8 builds on K-5 experiences and progresses to evaluating the merit and validity of ideas and methods.
- Gather, read, and synthesize evidence from multiple appropriate sources to 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-LS1-8)

Disciplinary Core Ideas

**LS1A: Structure and Function**
- All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1)
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)
- In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)

**LS1D: Information Processing**
- Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. (MS-LS1-8)
- (NYSED) Plants respond to stimuli such as gravity (geotropism) and light (phototropism). (MS-LS1-8)

Crosscutting Concepts

**Cause and Effect**
- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8)

**Scale, Proportion, and Quantity**
- Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1)

**Systems and System Models**
- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3) 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 structures/systems can be analyzed to determine how they function. (MS-LS1-2)

Connections to Engineering, Technology, and Applications of Science

**Interdependence of Science, Engineering, and Technology**
- 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. (MS-LS1-1)

Connections to Nature of Science

**Science is a Human Endeavor**
- Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-3)
MS-LS1-6. Develop a model to describe how food molecules are rearranged through chemical reactions to release energy during cellular respiration and/or form new molecules that support growth as this matter moves through an organism. (Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy associated with ongoing chemical reactions, and on describing the boundaries of the ecosystem.) [Assessment Boundary: Assessment does not include the use of chemical equations to describe the processes.]

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. (Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about shifts in populations due to changes in the ecosystem.)

**Disciplinary Core Ideas**

**LS1.C: Organization for Matter and Energy Flow in Organisms**
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7)

**LS2.A: Interdependent Relationships in Ecosystems**
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)

**LS2.B: Cycle of Matter and Energy Transfer in Ecosystems**
- Food web models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)

**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**
- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)

**PS3.D: Energy in Chemical Processes and Everyday Life**
- The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (MS-LS2-4)
- Cellular respiration in plants and animals involves chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (secondary to MS-LS1-7)

**Crosscutting Concepts**

**Cause and Effect**
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)

**Energy and Matter**
- Matter is conserved because atoms are conserved in physical and chemical processes. (MS-LS1-7)
- Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)
- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-4)

**Stability and Change**
- Small changes in one part of a system may cause large changes in another part. (MS-LS2-4)

**Connections to Nature of Science**

**Scientific Knowledge**
- Assumes an Order and Consistency in Natural Systems
- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3)
New York State P-12 Science Learning Standards

New York State Next Generation Learning Standards Connections:

**ELA/Literacy** -

6-8.RST.1 Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-LS1-6),(MS-LS2-1),(MS-LS2-4)

6-8.RST.2 Determine the central ideas or conclusions of a source; provide an accurate, objective summary of the source distinct from prior knowledge or opinion. (MS-LS1-6)

6-8.RST.7 Identify and match scientific or technical information present as text with a version of that information presented visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS2-4)

8.R.8 Trace and evaluate an argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient and recognizing when irrelevant evidence is introduced. (MS-LS2-4)

6-8.WHST.1 Write arguments focused on discipline content. (MS-LS2-4)

6-8.WHST.5 Conduct short research projects to answer a question (including a self-generated question by the end of grade 8), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-LS2-4)

6-8.WHST.9 Draw evidence from informational texts to support analysis, reflection and research. (MS-LS1-6),(MS-LS2-4)

8.SL.5 Integrate digital media and/or visual displays in presentations to clarify information, strengthen claims and evidence, and add elements of interest to engage the audience. (MS-LS1-7),(MS-LS2-3)

**Mathematics** -

NY-6.EE.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another. (MS-LS1-6), (MS-LS2-3)

*Connection boxes updated as of September 2018

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### MS. Interdependent Relationships in Ecosystems

**Science and Engineering Practices**

**Constructing Explanations and Designing Solutions**
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2)
- Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).
- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)

**Disciplinary Core Ideas**

**LS2.A: Interdependent Relationships in Ecosystems**
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions among organisms with environments, both living and nonliving, are shared. (MS-LS2-2)

**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**
- (NYSED) Biodiversity describes the variety of species found in Earth’s ecosystems. The completeness or integrity of an ecosystem’s biodiversity is often used as a measure of its health. (MS-LS2-5)

**LS4.D: Biodiversity and Humans**
- Changes in biodiversity can influence humans’ resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (secondary to MS-LS2-5)
- (NYSED) Humans impact biodiversity both positively and negatively. (secondary to MS-LS2-5)

**ETS1.B: Developing Possible Solutions**
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to MS-LS2-5)

**Crosscutting Concepts**

**Patterns**
- Patterns can be used to identify cause and effect relationships. (MS-LS2-5)

**Stability and Change**
- Small changes in one part of a system might cause large changes in another part. (MS-LS2-5)

### Connections to Nature of Science

**Science Addresses Questions About the Natural and Material World**
- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)

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**New York State P-12 Science Learning Standards**

**MS. Growth, Development, and Reproduction of Organisms**

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developing and Using Models</strong></td>
<td><strong>LS1.B: Growth and Development of Organisms</strong></td>
<td><strong>Cause and Effect</strong></td>
</tr>
<tr>
<td>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-LS3-2)</td>
<td>• Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2)</td>
</tr>
<tr>
<td>• Develop and use a model to describe phenomena. (MS-LS3-1) (MS-LS3-2)</td>
<td>Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)</td>
<td>• Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS1-4) (MS-LS3-1) (MS-LS4-5)</td>
</tr>
<tr>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td>Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS4-5)</td>
<td>(MS-LS4-5)</td>
</tr>
<tr>
<td>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.</td>
<td>Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS3-5)</td>
<td><strong>Structure and Function</strong></td>
</tr>
<tr>
<td>• Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-5)</td>
<td>Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual.</td>
<td>• Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1)</td>
</tr>
<tr>
<td><strong>Engaging in Argument from Evidence</strong></td>
<td>Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)</td>
<td><strong>Connections to Engineering, Technology, a Applications of Science</strong></td>
</tr>
<tr>
<td>Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).</td>
<td>Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2)</td>
<td>• 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. (MS-LS4-5)</td>
</tr>
<tr>
<td>• Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS1-4)</td>
<td><strong>LS3.B: Variation of Traits</strong></td>
<td><strong>Connections to Nature of Science</strong></td>
</tr>
<tr>
<td>Obtaining, Evaluating, and Communicating Information</td>
<td>In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2)</td>
<td>• Scientific knowledge, and describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS4-5)</td>
</tr>
<tr>
<td>Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.</td>
<td>In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS1-1)</td>
<td></td>
</tr>
<tr>
<td>• 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-LS4-5)</td>
<td>(NYSED) Mutations may result in changes to the structure and function of proteins. (MS-LS3-1)</td>
<td><strong>Science Addresses Questions About the Natural and Material World</strong></td>
</tr>
<tr>
<td><strong>LS4.B: Natural Selection</strong></td>
<td>In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5)</td>
<td><strong>Scientific knowledge, and describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS4-5)</strong></td>
</tr>
</tbody>
</table>
**New York State P-12 Science Learning Standards**

<table>
<thead>
<tr>
<th>Connections to other DCs in this grade-band:</th>
<th>MS.LS1.A (MS-LS3-1); MS.LS2.A (MS-LS1-4); MS.LS4.A (MS-LS3-1)</th>
</tr>
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<tbody>
<tr>
<td>Articulation to DCs across grade-bands:</td>
<td>3.LS1.B (MS-LS1-4); MS.LS1-5; 3.LS3.A (MS-LS3-1); (MS-LS3-2); 3.LS3.B (MS-LS3-1); (MS-LS3-2); HS.LS1.A (MS-LS3-1); HS.LS1.B (MS-LS1-3); (MS-LS3-2); HS.LS2.A (MS-LS1-4); (MS-LS1-5); HS.LS2.D (MS-LS1-4); HS.LS3.A (MS-LS3-1); (MS-LS3-2); HS.LS3.B (MS-LS3-1); (MS-LS3-2); (MS-LS4-5); HS.LS4.C (MS-LS4-5)</td>
</tr>
</tbody>
</table>

**New York State Next Generation Learning Standards Connections:**

**ELA/Literacy -**

- **6-8.RST.1** Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-LS1-4); (MS-LS1-5); (MS-LS3-1); (MS-LS3-2); (MS-LS4-5)
- **6-8.RST.2** Determine the central ideas or conclusions of a source; provide an accurate, objective summary of the source distinct from prior knowledge or opinion. (MS-LS1-5)
- **6-8.RST.4** Determine the meaning of symbols, key terms, and other content-specific words and phrases as they are used in scientific or technical sources. (MS-LS1-1); (MS-LS3-2)
- **6-8.RST.7** Identify and match scientific or technical information present as text with a version of that information presented visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS1-1); (MS-LS3-2)
- **6.R.8** Trace and evaluate the development of an argument and specific claims in a text, distinguishing claims that are supported by reasons and relevant evidence from the claims that are not. (MS-LS1-4)
- **6-8.WHST.1** Write arguments focused on discipline content. (MS-LS1-4)
- **6-8.WHST.2** Write informative/explanatory text focused on discipline-specific content. (MS-LS1-5)
- **6-8.WHST.8** Gather relevant information from multiple print and digital sources, using search terms effectively, assess the credibility and accuracy of each source by applying discipline specific criteria used in the social sciences or sciences; and quote or paraphrase the data/accounts and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS4-5)
- **6-8.WHST.9** Draw evidence from informational texts to support analysis, reflection and research. (MS-LS1-5)
- **8.SL.5** Integrate digital media and/or visual displays in presentations to clarify information, strengthen claims and evidence, and add elements of interest to engage the audience. (MS-LS3-1); (MS-LS3-2)

**Mathematics -**

- **MP.4** Model with mathematics. (MS-LS3-2)
- **NY-6.SP.2** Understand that a set of quantitative data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (MS-LS1-4); (MS-LS1-5)
- **NY-6.SP.4** Display quantitative data in plots on a number line, including dot plots, and histograms. (MS-LS1-4); (MS-LS1-5)
- **NY-6.SP.5** Summarize quantitative data sets in relation to their context. (MS-LS3-2)

*Connection boxes updated as of September 2018*
### New York State P-12 Science Learning Standards

#### MS. Natural Selection and Adaptations

**MS-LS4-1.** Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.]

**MS-LS4-2.** Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures as evidence of common ancestry.]

**MS-LS4-3.** Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]

**MS-LS4-4.** Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.]

**MS-LS4-6.** Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.]

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

### Science and Engineering Practices

- **Analyzing and Interpreting Data**
  - Analyzing data in 6–8 builds on K–5 experiences 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-LS4-1)

- **Using Mathematics and Computational Thinking**
  - Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.
  - Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6)

- **Constructing Explanations and Designing Solutions**
  - Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
  - Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2)
  - Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)

### Disciplinary Core Ideas

- **LS4.A: Evidence of Common Ancestry and Diversity**
  - The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1)
  - Analogical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2)
  - Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)

- **LS4.B: Natural Selection**
  - (NYSED) Natural selection can lead to an increase in the frequency of some traits and the decrease in the frequency of other traits. (MS-LS4-4)

- **LS4.C: Adaptation**
  - Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. (MS-LS4-5)
  - Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)

### Crosscutting Concepts

- **Patterns**
  - Patterns can be used to identify cause and effect relationships. (MS-LS4-2)
  - Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1)

- **Cause and Effect**
  - Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4), (MS-LS4-6)

### Connections to Nature of Science

- **Scientific Knowledge Assumes an Order and Consistency in Natural Systems**
  - Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS4-1), (MS-LS4-2)

### Connections to Other Disciplines

- **ELA/Literacy**
  - 6–8.RST.1 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS4-2), (MS-LS4-4)

- **8.SL.1** Engage effectively in a range of collaborative discussions with diverse partners; express ideas clearly and persuasively and build on those of others. (MS-LS4-2), (MS-LS4-4)

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</tr>
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<tr>
<td>8.SL.4</td>
<td>Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear enunciation. (MS-LS4-2),(MS-LS4-4)</td>
</tr>
<tr>
<td>Mathematics</td>
<td></td>
</tr>
<tr>
<td>MP.4</td>
<td>Model with mathematics. (MS-LS2-5)</td>
</tr>
<tr>
<td>NY-6.RP.1</td>
<td>Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-LS4-4),(MS-LS4-6)</td>
</tr>
<tr>
<td>NY-6.SP.5</td>
<td>Summarize quantitative data sets in relation to their context. (MS-LS4-4),(MS-LS4-6)</td>
</tr>
<tr>
<td>NY-6.EE.6</td>
<td>Use variables to represent numbers and write expressions when solving a real-world or mathematical problem. Understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-LS4-1),(MS-LS4-2)</td>
</tr>
<tr>
<td>NY-7-RP.2</td>
<td>Recognize and represent proportional relationships between quantities. (MS-LS4-4),(MS-LS4-6)</td>
</tr>
</tbody>
</table>

*Connection boxes updated as of September 2018

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### MS. Space Systems

**MS-ESS1-1. Develop and use a model of the Earth-Sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and moon, and seasons.** [Clarification Statement: Examples of models could include physical, graphical, or conceptual models.]

**MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.** [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models could include physical models (such as a model of the solar system scaled using various measures or computer visualizations of elliptical orbits) or conceptual models (such as mathematical proportions relative to the size of familiar objects such as students’ school or state).] [Assessment Boundary: Assessment does not include Kepler’s Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]

**MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.**

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

- Consistency in Natural Systems
- Scientific Knowledge Assumes an Order and Predictability
- Scale, Proportion, and Quantity
- Connections to other DCIs in this grade
- Interdependence of Science, Engineering, and Technology
- Scientific Knowledge Assumes an Order and Consistency in Natural Systems

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing and Using Models</td>
<td>ESS1A: The Universe and Its Stars</td>
<td>Patterns • Patterns can be used to identify cause and effect relationships. (MS-ESS1-1)</td>
</tr>
<tr>
<td>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>Patterns • Patterns can be used to identify cause and effect relationships. (MS-ESS1-1)</td>
<td></td>
</tr>
<tr>
<td>Analyzing and Interpreting Data</td>
<td>Patterns • Patterns can be used to identify cause and effect relationships. (MS-ESS1-1)</td>
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</tr>
<tr>
<td>Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.</td>
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<tr>
<td>Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3)</td>
<td>Patterns • Patterns can be used to identify cause and effect relationships. (MS-ESS1-1)</td>
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</tbody>
</table>

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

- MS.PS2.A (MS-ESS1-1),(MS-ESS1-2); MS.PS2.B (MS-ESS1-1),(MS-ESS1-2); MS.ESS2.A (MS-ESS1-3)
- MS.ESS1.A (MS-ESS1-1),(MS-ESS1-2); MS.ESS1.B: Earth and the Solar System (NYSED) The solar system consists of the Sun and a collection of objects, including planets, their moons, comets, and asteroids that are held in orbit around the Sun by its gravitational pull on them. (MS-ESS1-2),(MS-ESS1-3)
- MS.ESS1.B: Earth and the Solar System (NYSED) The solar system consists of the Sun and a collection of objects, including planets, their moons, comets, and asteroids that are held in orbit around the Sun by its gravitational pull on them. (MS-ESS1-2),(MS-ESS1-3)
- MS.ESS1.B: Earth and the Solar System (NYSED) The solar system consists of the Sun and a collection of objects, including planets, their moons, comets, and asteroids that are held in orbit around the Sun by its gravitational pull on them. (MS-ESS1-2),(MS-ESS1-3)
- HS.PS2.A (MS-ESS1-1),(MS-ESS1-2); HS.PS2.B (MS-ESS1-1),(MS-ESS1-2); HS.ESS1.A (MS-ESS1-2); HS.ESS1.B (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3); HS.ESS2.A (MS-ESS1-3)

### New York State Next Generation Learning Standards:

**ELA/Literacy - 6-8.RST.1** Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-ESS1-3)

**6-8.RST.7** I dentify and match scientific or technical information present as text with a version of that information presented visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS1-3)

**8.SL.5** Integrate digital media and/or visual displays in presentations to clarify information, strengthen claims and evidence, and add elements of interest to engage the audience. (MS-ESS1-1),(MS-ESS1-2)

**Mathematics - 6.P.2** Reason abstractly and quantitatively. (MS-ESS1-3)

**6.P.4** Model with mathematics. (MS-ESS1-1),(MS-ESS1-2)

**NY-6.RP.1** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3)

**NY-7.RP.2** Recognize and represent proportional relationships between quantities. (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3)

**NY-6.EE.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem. Understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-2)

**NY-7.EE.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-2)

*Connection boxes updated as of September 2018* Connection boxes updated as of September 2018

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The text in the “Disciplinary Core Ideas” section is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas unless it is preceded by (NYSED).*
**Science and Engineering Practices**

Analyzing and Interpreting Data

- Analyzing data in 6–8 builds on K–5 and progresses to include extended quantitative analysis to investigate, distinguishing between correlation and causation, and basic scientific techniques of data and error analysis.
- Analyze and interpret data to provide evidence for phenomena. (MS-ESS2-3)

Constructing Explanations and Designing Solutions

- Constructing explanations and designing solutions in 6–8 builds on K–5 and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS1-4), (MS-ESS2-2)

**Disciplinary Core Ideas**

**ESS1.C: The History of Planet Earth**

- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)
- Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (HS.ESS1.C GB) (secondary to MS-ESS2-3)

**ESS2.A: Earth's Materials and Systems**

- The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2)

**ESS2.B: Plate Tectonics and Large-Scale System Interactions**

- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3)

**ESS2.C: The Roles of Water in Earth's Surface Processes**

- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2)

**Connections to Nature of Science**

- **Science and Engineering Practices**
  - Science is a human endeavor, and our understanding of the natural world is always provisional, subject to change as new evidence is discovered and old evidence is reinterpreted based on new evidence. (MS-ESS2-3)

- **Disciplinary Core Ideas**
  - **ESS1.C: The History of Planet Earth**
    - The geologic time scale (MS-ESS1-4)
    - Tectonic processes (HS.ESS1.C GB) (secondary to MS-ESS2-3)

- **ESS2.A: Earth's Materials and Systems**
  - The planet's systems interact (MS-ESS2-2)

- **ESS2.B: Plate Tectonics and Large-Scale System Interactions**
  - Maps of ancient land and water patterns (MS-ESS2-3)

- **ESS2.C: The Roles of Water in Earth's Surface Processes**
  - Water's movements (MS-ESS2-2)

**Crosscutting Patterns**

- **Science and Engineering Practices**
  - Analyzing and interpreting data (MS-ESS2-3)

- **Disciplinary Core Ideas**
  - **ESS1.C: The History of Planet Earth**
    - The geologic time scale (MS-ESS1-4)
  - **ESS2.A: Earth's Materials and Systems**
    - The planet's systems interact (MS-ESS2-2)
  - **ESS2.B: Plate Tectonics and Large-Scale System Interactions**
    - Maps of ancient land and water patterns (MS-ESS2-3)
  - **ESS2.C: The Roles of Water in Earth's Surface Processes**
    - Water's movements (MS-ESS2-2)

**New York State Next Generation Learning Standards Connections: ELA/Literacy**

- **6-8.RST.1** Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-ESS1-4), (MS-ESS2-2), (MS-ESS2-3)
- **6-8.RST.7** Identify and match scientific or technical information present in text with a version of that information presented visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS2-3)
- **6-8.RST.9** Compare and contrast the information gained from two or more experiments, simulations, videos, multimedia sources, readings from texts, graphs, charts, etc., on the same topic. (MS-ESS2-3)
- **6-8.WHST.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS1-4), (MS-ESS2-2)
- **8.SL.5** Integrate digital media and/or visual displays in presentations to clarify information, strengthen claims and evidence, and add elements of interest to engage the audience. (MS-ESS2-2)

**Mathematics**

- **MP.2** Reason abstractly and quantitatively. (MS-ESS2-2), (MS-ESS2-3)
- **NY-6.EE.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem. Understand that a variable can represent an unknown number, or depending on the purpose at hand, any number in a specified set. (MS-ESS1-4), (MS-ESS2-2), (MS-ESS2-3)
- **NY-7.EE.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about quantities. (MS-ESS1-4), (MS-ESS2-2), (MS-ESS2-3)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas unless it is preceded by (NYSED)."
Students who demonstrate understanding can:

**MS-ESS2-1.** Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process. [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth’s materials.] [Assessment Boundary: Assessment does not include the specific identification and naming of minerals and rocks but could include the general classification of rocks as igneous, metamorphic, or sedimentary.]

**MS-ESS2-4.** Develop a model to describe the cycling of water through Earth’s systems driven by energy from the Sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models could include conceptual or physical models.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

**MS-ESS3-1** Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geologic processes. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes could include petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]

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**Science and Engineering Practices**

**Developing and Using Models**

Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-ESS2-1)
- Develop a model to describe unobservable mechanisms. (MS-ESS2-4)

**Constructing Explanations and Designing Solutions**

Constructing explanations and designing solutions in 6-8 builds on K-5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1)

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**Disciplinary Core Ideas**

**ESS2.A: Earth’s Materials and Systems**

- All Earth processes are the result of energy flowing and matter cycling within and among the planet’s systems. This energy is derived from the sun and Earth’s hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth’s materials and living organisms. (MS-ESS2-1)

**ESS2.C: The Roles of Water in Earth’s Surface Processes**

- (NYSED) Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation, sublimation, deposition, precipitation, infiltration, and runoff. (MS-ESS2-4)
- (NYSED) Global movements of water and its changes in form are driven by sunlight and gravity. (MS-ESS2-4)

**ESS3.A: Natural Resources**

Humans depend on Earth’s land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1)

**Crosscutting Concepts**

**Cause and Effect**

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1)

- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS4-4)

**Stability and Change**

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MS-ESS2-1)

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**Connections to Engineering, Technology, and Applications of Science**

**Influence of Science, Engineering, and Technology on Society and the Natural World**

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1)

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**New York State Next Generation Learning Standards**

**ELA/Literacy**

- **6-8.RST.1** Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-ESS1-1)
- **6-8.WHST.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS1-1)
- **6-8.WHST.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (MS-ESS1-1)
- **8.SL.5** Integrate digital media and/or visual displays in presentations to clarify information, strengthen claims and evidence, and add elements of interest to engage the audience. (MS-ESS1-1)

**Mathematics**

- **NY-6.EE.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem. Understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-1)
- **NY-7.EE.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-1)

*Connection boxes updated as of September 2018*
MS. Weather and Climate

Students who demonstrate understanding can:

**MS-ESS2-5.** Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. [Clarification Statement: Emphasis is on how air flows from regions of high pressure to low pressure, the complex interactions at air mass boundaries, and the movements of air masses affect weather (defined by temperature, pressure, humidity, precipitation, and wind at a fixed location and time). Emphasis is on how weather can be predicted within probabilistic ranges. Data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation). [Assessment Boundary: Assessment includes the application of weather data systems but does not include recalling the names of cloud types, weather symbols used on weather maps, the reported diagrams from weather stations, or the interrelationship of weather variables.]

**MS-ESS2-6.** Develop and use a model to describe how unequal heating and rotation of Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis is on the sun-driven, latitudinal banding causing differences in density that create convection currents in the atmosphere, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the oceanic circulation cycle, which is constrained by the Coriolis effect and the coastlines of continents. Examples of models could include diagrams, maps and globes, or digital representations. [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]

**MS-ESS3-5.** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors could include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence could include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

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

**Science and Engineering Practices**

* Asking Questions and Defining Problems
  - Asking questions and defining problems in 6-8 builds on K-5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.
  - Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5)

* Developing and Using Models
  - Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
  - Develop and use a model to describe phenomena. (MS-ESS2-6)

* Planning and Carrying Out Investigations
  - Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.
  - Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)

**Disciplinary Core Ideas**

**ESS2.C: The Roles of Water in Earth’s Surface Processes**
- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean conditions, are major determinants of local weather patterns. (MS-ESS2-5)
- Variations in density due to variations in temperature and salinity drive a pattern of interconnected ocean currents. (MS-ESS2-6)

**ESS2.D: Weather and Climate**
- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions are driven by latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6)
- Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)

**ESS3.D: Global Climate Change**
- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the recent rise in Earth’s mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

**Crosscutting Concepts**

**Cause and Effect**
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)

**Systems and System Models**
- Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6)

**Stability and Change**
- Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)

**Articulation of DCIs across grade-bands:**
- **ESS3-1A** (MS-ESS2-5); **ESS3-2A** (MS-ESS2-5, MS-ESS2-6); **ESS3-3A** (MS-ESS2-5, MS-ESS2-6); **ESS3-4A** (MS-ESS2-5, MS-ESS2-6), **ESS3-5A** (MS-ESS2-5)
- **ESS3-1B** (MS-ESS2-5); **ESS3-2B** (MS-ESS2-5, MS-ESS2-6); **ESS3-3B** (MS-ESS2-5, MS-ESS2-6); **ESS3-4B** (MS-ESS2-5, MS-ESS2-6); **ESS3-5B** (MS-ESS2-5, MS-ESS2-6)
- **ESS3-1C** (MS-ESS2-5); **ESS3-2C** (MS-ESS2-5, MS-ESS2-6); **ESS3-3C** (MS-ESS2-5, MS-ESS2-6); **ESS3-4C** (MS-ESS2-5, MS-ESS2-6)
- **ESS3-2D** (MS-ESS2-5, MS-ESS2-6, MS-ESS2-7); **ESS3-3D** (MS-ESS2-5, MS-ESS2-6, MS-ESS2-7)

**New York State Next Generation Learning Standards: ELA/Literacy**
- **6-8.RST.1** Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-ESS2-5, MS-ESS3-5)
- **6-8.RST.9** Compare and contrast the information gained from two or more experiments, simulations, videos, multimedia sources, readings from texts, graphs, charts, etc., on the same topic. (MS-ESS2-5)
- **6-8.WHST.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source by applying discipline-specific criteria used in the social sciences or sciences, and quote or paraphrase the data/accounts and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS2-5)
- **8.LS.5** Integrate digital media and/or visual displays in presentations to clarify information, strengthen claims and evidence, and add elements of interest to engage the audience. (MS-ESS2-6)

**Mathematics**
- **MP.2** Reason abstractly and quantitatively. (MS-ESS2-5, MS-ESS3-5)
- **NY-6.NS.5** Understand that positive and negative numbers are used together to describe quantities having opposite directions or values. Use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)
- **NY-6.EE.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem. Understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-5)
- **NY-7.EE.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-5)

*Connection boxes updated as of September 2018

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Students who demonstrate understanding can:

MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the
development of technologies to mitigate their effects. [Clarification Statement: Emphasis is on how some natural hazards,
such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes,
occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards could include those resulting from interior
processes (such as earthquakes and volcanic eruptions) and surface processes (such as mass wasting and tsunamis), or from severe weather events
(such as blizzards, hurricanes, tornadoes, floods, and droughts). Examples of data could include the locations, magnitudes, and frequencies of the
natural hazards. Examples of technologies could include global technologies (such as satellite images to monitor hurricanes or forest fires) or local
technologies (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the
environment.* [Clarification Statement: Examples of the design process could include examining human environmental impacts, assessing
the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts could
include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as
urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita
consumption of natural resources impact Earth’s systems. [Clarification Statement: Examples of evidence could include
grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and
energy). Examples of impacts could include changes to the appearance, composition, and structure of Earth’s systems as well as the rates at which they
change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not
make the decisions for the actions society takes.]

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

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 6-8 builds on K-5 experiences 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-ESS3-2)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6-8 builds on K-5 experiences and progresses to
include constructing explanations and designing solutions supported by multiple sources of evidence
consistent with scientific ideas, principles, and theories.
• Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3)

Engaging in Argument from Evidence
Engaging in argument from evidence in 6-8 builds on K-5 experiences and progresses to constructing a
convincing argument that supports or refutes claims for either explanations or solutions about the natural
and designed world(s).
• Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or
a model for a phenomenon or a solution to a problem. (MS-ESS3-4)

Disciplinary Core Ideas

ESS3.B: Natural Hazards
• Mapping the history of natural hazards in a region, combined with an understanding of related geologic
forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2)

ESS3.C: Human Impacts on Earth Systems
• Human activities have significantly altered the biosphere, sometimes damaging or destroying natural
habitats and causing the extinction of other species. But changes to Earth’s environments can have different
impacts (negative and positive) for different living things. (MS-ESS3-3)
• Typically as human populations and per-capita consumption of natural resources increase, so do the negative
impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4)

Crosscutting Concepts

Patterns
• Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2)

Cause and Effect
• Relationships can be classified as causal or correlation, and correlation does not necessarily imply causation. (MS-ESS3-3)
• Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-4)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World
• All human activity draws on natural resources and has both short and long-term consequences, positive as well as
negative, for the health of people and the natural environment. (MS-ESS3-4)
• The uses 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. (MS-ESS3-2),(MS-ESS3-3)

Connections to Nature of Science

Science Addresses Questions About the Natural and Material World
Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society
takes. (MS-ESS3-4)

Connections to other DCIs in this grade-band: MS.PS3.C (MS-ESS3-2); MS.LS2.A (MS-ESS3-3),(MS-ESS3-4); MS.LS2.C (MS-ESS3-3),(MS-ESS3-4); MS.LS4.D (MS-ESS3-3),(MS-ESS3-4)
New York State P-12 Science Learning Standards

<table>
<thead>
<tr>
<th>Mathematics:</th>
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<tbody>
<tr>
<td><strong>MP.2</strong> Reason abstractly and quantitatively. (MS-ESS3-2)</td>
</tr>
<tr>
<td><strong>NY-6.RP.1</strong> Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS3-3),(MS-ESS3-4)</td>
</tr>
<tr>
<td><strong>NY-7.RP.2</strong> Recognize and represent proportional relationships between quantities. (MS-PS4-1)</td>
</tr>
<tr>
<td><strong>NY-6.EE.6</strong> Use variables to represent numbers and write expressions when solving a real-world or mathematical problem. Understand that a variable can represent and unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-4),(MS-ESS2-2),(MS-ESS2-3)</td>
</tr>
<tr>
<td><strong>NY-7.EE.4</strong> Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-4), (MS-ESS2-2),(MS-ESS2-3)</td>
</tr>
</tbody>
</table>

*Connection boxes updated as of September 2018*

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The text in the “Disciplinary Core Ideas” section is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas unless it is preceded by (NYSED).*
**New York State P-12 Science Learning Standards**

**MS. Engineering Design**

Students who demonstrate understanding can:

**MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

**MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

**MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

**MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

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**Science and Engineering Practices**

**Asking Questions and Defining Problems**

Asking questions and defining problems in grades 6–8 builds on K–5 experiences and progresses to identifying and clarifying arguments and models.

- Define a design problem that can be solved through the development of an object, tool, or system and includes scientific knowledge that may limit possible solutions. (MS-ETS1-1)

**Developing and Using Models**

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-2)

**Analyzing and Interpreting Data**

Analyzing data in 6–8 builds on K–5 experiences and progresses to engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.

- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)

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**Disciplinary Core Ideas**

**ETS1A: Defining and Delimiting Engineering Problems**

- The more precisely a design task’s criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)

**ETS1B: Developing Possible Solutions**

- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)

**ETS1C: Optimizing the Design Solution**

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3)

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**Crosscutting Concepts**

- Influence of Science, Engineering, and Technology on Society and the Natural World
  - All human activities draw on natural resources and have both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1)
  - The uses of technologies and 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. (MS-ETS1-1)

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**New York State Next Generation Learning Standards Connections:**

**ELA/Literacy -**

6-8.RST.1 Omit specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)

6-8.RST.7 Identify and match scientific or technical information present as text with a version of that information represented visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ETS1-3)

6-8.RST.9 Compare and contrast the information gained from two or more experiments, simulations, videos, multimedia sources, readings from texts, graphs, charts, etc., on the same topic. (MS-ETS1-2),(MS-ETS1-3)

6-8.WHST.7 Conduct short research projects to answer a question (including a self-generated question by the end of grade 8), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)

6-8.WHST.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source by applying discipline specific criteria used in the social sciences or sciences; and quote or paraphrase the data/accounts and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ETS1-1)

6-8.WHST.9 8.SL.5 Integrate digital media and/or visual displays in presentations to clarify information, strengthen claims and evidence, and add elements of interest to engage the audience. (MS-ETS1-4)

**Mathematics -**

MP.2 Reason abstractly and quantitatively. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4)

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| NY-7.EE.3 | Solve multi-step real-world and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate. Assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3) |

*Connection boxes updated as of September 2018*