### Science and Engineering Practices

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

**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)

**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.
  - 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)

**Obtaining, Evaluating, and Communicating Information**
- Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods.
  - Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-PS1-3)

### Disciplinary Core Ideas

#### PS1.A: Structure and Properties of Matter
- **(NYSED)** Substances are made of one of type of atom or combinations of different types of atoms.
  - Individual atoms are particles and can combine to form larger particles that range in size from two to thousands of atoms. (MS-PS1-1)
  - (NYSED) Each substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3), (MS-PS1-7) (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)
  - 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-PS1-5)

#### 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.A: Definitions of Energy
- **(NYSED)** The term “heat” as used in everyday language refers to both 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**
  - Macroscopic 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 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-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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<thead>
<tr>
<th>ELA/Literacy</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6-8RST1</strong></td>
<td>Reason abstractly and quantitatively. (MS-PS1-1), (MS-PS1-8)</td>
</tr>
<tr>
<td><strong>6-8RST7</strong></td>
<td>Model with mathematics. (MS-PS1-1)</td>
</tr>
<tr>
<td><strong>6-8WHST.8</strong></td>
<td>Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-1), (MS-PS1-7)</td>
</tr>
<tr>
<td><strong>NY-6.RP.4</strong></td>
<td>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)</td>
</tr>
<tr>
<td><strong>NY-8.EE.3</strong></td>
<td>Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. (MS-PS1-1)</td>
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New York State P-12 Science Learning Standards

MS. Chemical Reactions

Students who demonstrate understanding can:

**MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.** [Clarification Statement: Examples of chemical reactions could include burning of a wooden splint, souring of milk and decomposition of sodium bicarbonate. [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, color change, gas production and odor.]

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

**MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy during a chemical and/or physical process.* [Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and amount of a substance. Examples of designs could include combining vinegar and baking soda, activating glow sticks at various temperatures and dissolving ammonium chloride or calcium chloride.] [Assessment Boundary: Assessment is limited to the criteria of substance amounts, reaction time, and observed temperature changes.]

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

<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>PS1.A: Structure and Properties of Matter</strong></td>
<td><strong>Patterns</strong></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>(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)</td>
<td>• Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)</td>
</tr>
<tr>
<td><em>Develop a model to describe unobservable mechanisms. (MS-PS1-5)</em></td>
<td><strong>PS1.B: Chemical Reactions</strong></td>
<td><strong>Energy and Matter</strong></td>
</tr>
<tr>
<td>Analyzing and Interpreting Data</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>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><strong>PS1.B: The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)</strong></td>
<td>• The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)</td>
</tr>
<tr>
<td><em>Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2)</em></td>
<td><strong>ETS1.B: Developing Possible Solutions</strong></td>
<td></td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (secondary to MS-PS1-6)</td>
<td></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><strong>ETS1.C: Optimizing the Design Solution</strong></td>
<td></td>
</tr>
<tr>
<td><em>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)</em></td>
<td>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 the characteristics may be incorporated into the new design. (secondary to MS-PS1-6)</td>
<td></td>
</tr>
<tr>
<td><em>The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (secondary to MS-PS1-6)</em></td>
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</tr>
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</table>

**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-PS1-2)

**Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**

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

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


**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-PS1-2)
- **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-PS1-2), (MS-PS1-5)
- **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-PS1-6)

**Mathematics**

- **MP.2** Reason abstractly and quantitatively. (MS-PS1-2), (MS-PS1-5)
- **MP.4** Model with mathematics. (MS-PS1-5)
- **NY-6.RP.3** Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-2), (MS-PS1-5)
- **NY-6.SP.4** Display quantitative data in plots on a number line, including dot plots, histograms, and box plots. (MS-PS1-2)
- **NY-6.SP.5** Summarize quantitative data sets in relation to their context (MS-PS1-2)

*Connection boxes updated as of September 2018

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New York State P-12 Science Learning Standards

MS. Forces and Interactions

Students who demonstrate understanding can:

**MS-PS2-1.** Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.*[Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.]

**MS-PS2-2.** Plan and conduct an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.* [Clarification Statement: Emphasis is on balanced (Newton’s First Law) and unbalanced forces in a system (including simple machines), qualitative comparisons of forces, mass and changes in motion (Newton’s Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]

**MS-PS2-3.** Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.* [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]

**MS-PS2-4.** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects and the distance between them.* [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton’s Law of Gravitation or Kepler’s Laws.]

**MS-PS2-5.** Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.* [Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations. Emphasis should be on using arrows to represent the directions of force and by differences in such fields as electric and magnetic fields, and is limited to qualitative evidence for the existence of fields.]

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Science and Engineering Practices

**Asking Questions and Defining Problems**

**Planning and Carrying Out Investigations**

**Constructing Explanations and Designing Solutions**

**Engaging in Argument from Evidence**

**Science Knowledge is Based on Empirical Evidence**

**Disciplinary Core Ideas**

**MS-PS2-A: Forces and Motion**

For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton’s third law). (MS-PS2-3)

The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to change the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)

**MS-PS2-B: Types of Interactions**

Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3)

Gravitational forces are always attractive. There is a gravitational force between any two masses. It is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)

Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). (MS-PS2-5)

**Crossettling Concepts**

**Cause and Effect**

**Stability and Change**

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

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<td>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-PS2-1),(MS-PS2-3)</td>
</tr>
<tr>
<td><strong>6-8.WHST.1</strong></td>
<td>Write arguments based on discipline-specific content. (MS-PS2-4)</td>
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<td><strong>6-8.WHST.7</strong></td>
<td>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)</td>
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<td><strong>MP.2</strong></td>
<td>Reason abstractly and quantitatively. (MS-PS2-1),(MS-PS2-2),(MS-PS2-3)</td>
</tr>
<tr>
<td><strong>NY-6.NS.5</strong></td>
<td>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)</td>
</tr>
<tr>
<td><strong>NY-6.EE.2</strong></td>
<td>Write, read, and evaluate expressions in which letters stand for numbers. (MS-PS2-1),(MS-PS2-2)</td>
</tr>
<tr>
<td><strong>NY-7.EE.3</strong></td>
<td>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)</td>
</tr>
<tr>
<td><strong>NY-7.EE.4</strong></td>
<td>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)</td>
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*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 data.]  
- 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)  

**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.]  

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*.
### 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).

**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)

**New York State Next Generation Learning Standards**

**Connections: ELA/Literacy**

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<td>6-8.RST.7</td>
<td>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)</td>
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<td>6-8.WHST.1</td>
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<td>6-8.WHST.7</td>
<td>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)</td>
</tr>
<tr>
<td>8.SL.5</td>
<td>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)</td>
</tr>
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</table>

**Mathematics**

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<tbody>
<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-PS3-1),(MS-PS3-5),(MS-PS3-6)</td>
</tr>
<tr>
<td>NY-6.RP.2</td>
<td>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)</td>
</tr>
<tr>
<td>NY-7.RP.2</td>
<td>Recognize and represent proportional relationships between quantities. (MS-PS3-1),(MS-PS3-5)</td>
</tr>
<tr>
<td>NY-8.EE.1</td>
<td>Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)</td>
</tr>
<tr>
<td>NY-8.EE.2</td>
<td>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)</td>
</tr>
<tr>
<td>NY-8.F.3</td>
<td>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)</td>
</tr>
<tr>
<td>NY-6.SP.5</td>
<td>Summarize quantitative data sets in relation to their context. (MS-PS3-4)</td>
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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: 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 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-PS4-2)

**Using Mathematics and Computational Thinking**
- Mathematical and computational thinking at the 6-8 level builds on K-5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.
  - Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1)

**Obtaining, Evaluating, and Communicating Information**
- Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods.
  - Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3)

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### Disciplinary Core Ideas

**PS4.A: Wave Properties**
- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)
- A sound wave needs a medium through which it is transmitted. (MS-PS4-2)

**PS4.B: Electromagnetic Radiation**
- When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object’s material and the frequency (color) of the light. (MS-PS4-2)
  - (NYSED) The path that light travels can be traced as straight lines, except when it hits a surface between different transparent materials (e.g., air and water, air and glass) obliquely where the light path bends. (MS-PS4-2)
  - A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2)
  - (NYSED) However, because light can travel through space, it cannot be a mechanical wave, like sound or water waves. (MS-PS4-2)

**PS4.C: Information Technologies and Instrumentation**
- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)

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### Crosscutting Concepts

**Patterns**
- Graphs and charts can be used to identify patterns in data. (MS-PS4-1)

**Structure and Function**
- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS4-2)
- Structures can be designed to serve particular functions. (MS-PS4-3)

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### Connections to Nature of Science

Science is a Human Endeavor
- Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)

**Influence of Science, Engineering, and Technology on Society and the Natural World**
- Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3)

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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-PS4-3)
- **6-8.RST.2** Determine the central ideas or conclusions of a source; provide an objective summary of the text distinct from prior knowledge or opinions. (MS-PS4-3)
- **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-PS4-3)
- **6-8.WHST.9** 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-PS4-3)
- **8.SL.5** Reason abstractly and quantitatively. (MS-PS4-1)

**Mathematics**
- **MP.2** Model with mathematics. (MS-PS4-1)
- **NY-6.RP.1** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS4-1)
- **NY-6.RP.3** Use ratio and rate reasoning to solve real-world mathematical problems. (MS-PS4-1)
- **NY-7.RP.2** Recognize and represent proportional relationships between quantities. (MS-PS4-1)
- **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-PS4-1)

*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).*
### MS-LS1. Plan and conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. 
- **Clarification Statement:** Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.

### MS-LS1.2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
- **Clarification Statement:** Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall. 
- **Assessment Boundary:** Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical details related to the functions of cells or cell parts.

### MS-LS1.3. Construct an explanation supported by evidence for how the body is composed of interacting systems consisting of cells, tissues, and organs working together to maintain homeostasis.
- **Clarification Statement:** Emphasis should be on the function and interactions of the major body systems (e.g. circulatory, respiratory, nervous, musculoskeletal).
- **Assessment Boundary:** Assessment is focused on the interactions between systems not on the functions of individual systems.

### MS-LS1.8. Gather and synthesize information that sensory receptors respond to stimuli, resulting in immediate behavior and/or storage as memories.
- **Assessment Boundary:** Assessment does not include mechanisms for the transmission of this information.

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#### Disciplinary Core Ideas

**LS1.A: 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)

**LS1.D: 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)

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#### 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)

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#### 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)

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#### 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)

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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.

**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 a model to describe phenomena. (MS-LS2-3)
  - Develop a model to describe unobservable mechanisms. (MS-LS1-7)

- 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 provide evidence for phenomena. (MS-LS2-1)

- Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in 6-8 builds on K-5 experiences and progresses to including constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
  - Construct a scientific explanation based on evidence and scientific reasoning to support claims for how the world operate today as they did in the past and will continue to do so in the future. (MS-LS1-6)
  - Engaging in Argument from Evidence: Engaging in evidence from evidence in 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-LS2-4)

**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-LS1-2)
- 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-LS1-2)
- Growth of organisms and population increases are limited by access to resources. (MS-LS1-2)

**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-LS2-2)
- Small changes in one part of a system may cause large changes in another part. (MS-LS2-4)

**Crosscutting Concepts**

- **Cause and Effect:** Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS1-2)
- **Energy and Matter:** Matter is conserved because atoms are conserved in physical and chemical processes. (MS-LS1-7)
- **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 Assesses 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)

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

**ELA/Literacy -**

<table>
<thead>
<tr>
<th>6-8.RST.1</th>
<th>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)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-8.RST.2</td>
<td>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)</td>
</tr>
<tr>
<td>6-8.RST.7</td>
<td>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)</td>
</tr>
<tr>
<td>8.R.8</td>
<td>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)</td>
</tr>
<tr>
<td>6-8.WHST.1</td>
<td>Write arguments focused on discipline content. (MS-LS2-4)</td>
</tr>
<tr>
<td>6-8.WHST.5</td>
<td>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)</td>
</tr>
<tr>
<td>6-8.WHST.9</td>
<td>Draw evidence from informational texts to support analysis, reflection and research. (MS-LS1-6), (MS-LS2-4)</td>
</tr>
<tr>
<td>8.SL.5</td>
<td>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)</td>
</tr>
</tbody>
</table>

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

**MS. Interdependent Relationships in Ecosystems**

**Constructing Explanations and Designing Solutions**

**Disciplinary Core Ideas**

**Crosscutting Concepts**

**Science and Engineering Practices**

**Science Addresses Questions About the Natural and Material World**

Students who demonstrate understanding can:

- **MS-LS2-2.** Construct an explanation that predicts patterns of interactions among organisms in a variety of ecosystems. (Clarification Statement: Emphasis is on predicting patterns of interactions such as competition, predation, mutualism, and parasitism in different ecosystems in terms of the relationships among and between organisms.)

- **MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and protecting ecosystem stability.*

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New York State P-12 Science Learning Standards

MS. Growth, Development, and Reproduction of Organisms

Students who demonstrate understanding can:

**MS-LS1-4.** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively. [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, hindering of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]

**MS-LS1-5.** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include the genes responsible for size differences in different breeds of dogs. Examples of evidence could include drought decreasing plant growth, fertilizing increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, biochemical processes, or natural selection.]

**MS-LS3-1.** Develop and use a model to explain why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. [Clarification Statement: Mutations in body cells are not inherited. Emphasis is on understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.]

**MS-LS3-2.** Develop and use a model to describe how asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. [Clarification Statement: Emphasis is on using models such as diagrams and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring.]

**MS-LS4-5.** Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, selective breeding, gene therapy); and, on the impacts these technologies have on society.]

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

<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><strong>LS1.B:</strong> Growth and Development of Organisms</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.</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-LS1-5), (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-LS1-4)</td>
<td><strong>Structure and Function</strong></td>
</tr>
<tr>
<td>Constructing explanations and design solutions in 6–8 builds on K–5 experiences and progresses to constructing and designing explanations and design 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-LS1-5)</td>
<td>• Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on their shapes, composition, and relationships among its parts, therefore complex natural systems can be analyzed to determine how they function. (MS-LS3-1)</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><strong>Connections to Engineering, Technology, and Applications of Science</strong></td>
<td><strong>-</strong></td>
</tr>
<tr>
<td><strong>Engaging in Argument from Evidence</strong></td>
<td><strong>LS3.A:</strong> Inheritance of Traits</td>
<td><strong>Interdependence of Science, Engineering, and Technology</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>- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many different genes. Each distinct gene controls the production of specific proteins, which in turn affects the traits of the individual.</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.</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>-</strong></td>
</tr>
<tr>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></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><strong>Connections to Nature of Science</strong></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><strong>LS3.B:</strong> Variation of Traits</td>
<td><strong>Science Addresses Questions About the Natural and Material World</strong></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.</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><strong>LS4.B:</strong> Natural Selection</td>
<td>- In addition to variations that arise from sexual reproduction, genetic variation can be altered because of mutations. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)</td>
<td><strong>-</strong></td>
</tr>
<tr>
<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>- (NYSED) Mutations may result in changes to the structure and function of proteins. (MS-LS3-1)</td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>

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**Connections to other DCIs in this grade-band:**  
|----------|----------|----------|

**Articulation to DCIs across grade-bands:**  
|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|

**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-LS3-1),(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  
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*
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: Practices, Crosscutting Concepts, and Core Ideas* unless it is preceded by (NYSED)
### 8.SL.4
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)

### Mathematics

**MP.4**
Model with mathematics. (MS-LS2-5)

**NY-6.RP.1**
Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-LS4-4),(MS-LS4-6)

**NY-6.SP.5**
Summarize quantitative data sets in relation to their context. (MS-LS4-4),(MS-LS4-6)

**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-LS4-1),(MS-LS4-2)

**NY-7.RP.2**
Recognize and represent proportional relationships between quantities. (MS-LS4-4),(MS-LS4-6)

*Connection boxes updated as of September 2018*
**Students who demonstrate understanding can:**

**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.  
*Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties could include the sizes of an object’s layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data could include statistical information, drawings and photographs, and models. [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]*

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**Science and Engineering Practices**

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</table>
| 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. | **ESS1A:** The Universe and Its Stars  
- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1)  
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2) | **Patterns**  
- Patterns can be used to identify cause and effect relationships. (MS-ESS1-1) |
| Analyzing and Interpreting Data | **ESS1B:** 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)  
- This model of the solar system can explain eclipses of the sun and the moon. Earth’s spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)  
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2) | **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-ESS1-3) |
| Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3) | Systems and Model | **Connections to Engineering, Technology, and Applications of Science** |

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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-ESS1-3) |
| 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-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**

| MP.2 | Reason abstractly and quantitatively. (MS-ESS1-3) |
| MP.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) |

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

**MS. History of Earth**

Students who demonstrate understanding can:

**MS-ESS1-4.** Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth’s 4.6-billion-year-old history. [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth’s history. Examples of Earth’s major events or evidence could include very recent events or evidence (such as the last Ice Age or the earliest fossils of Homo sapiens) to very old events or evidence (such as the formation of Earth or the earliest evidence of life). Examples of evidence could include the formation of mountain chains and ocean basins, the evolution or extinction of particularly living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them, radiometric dating using half-lives, and defining index fossils.]

**MS-ESS2-2.** Construct an explanation based on evidence for how geoscience processes have changed Earth’s surface at varying temporal and spatial scales. [Clarification Statement: Emphasis is on how processes change Earth’s surface at temporal and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochanical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes that could include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]

**MS-ESS2-3.** Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. [Clarification Statement: Examples of data could include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches.) [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]

The performance expectations above were developed using the following elements from the NRC document: A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.
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).]

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 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)

Disciplinary Core Ideas

ES52.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)

ES52.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)

ES53.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)

Connecting to other DCIs in this grade-band: MS.PS1.A (MS-ESS2-1), (MS-ESS2-4), (MS-ESS3-1); MS.PS1.B (MS-ESS2-1), (MS-ESS3-1); MS.PS2.B (MS-ESS2-4); MS.PS3.A (MS-ESS2-1), (MS-ESS2-4); MS.PS3.B (MS-ESS2-1), (MS-ESS2-4); MS.PS3.D (MS-ESS2-1), (MS-ESS2-4); MS.LS2.B (MS-ESS2-1); MS.LS2.C (MS-ESS2-1); MS.ESS1.B (MS-ESS2-1); MS.ESS2.D (MS-ESS3-1); MS.ESS3.C (MS-ESS2-1)

Articulation of DCIs across grade-bands: 3.PS2.A (MS-ESS2-4); 4.PS3.B (MS-ESS2-1), (MS-ESS2-4); 4.PS3.D (MS-ESS2-1), (MS-ESS3-1); 4.ESS2.A (MS-ESS2-1), (MS-ESS2-4); 4.ESS2.A (MS-ESS2-1), (MS-ESS3-1); 5.PS2.B (MS-ESS2-4); 5.ESS2.A (MS-ESS2-1), 5.ESS2.C (MS-ESS2-4); MS.PS1.B (MS-ESS2-1); MS.PS2.B (MS-ESS2-4); MS.PS3.B (MS-ESS2-1), (MS-ESS2-4), (MS-ESS3-1); HS.PS4.B (MS-ESS2-4), HS.LS1.C (MS-ESS2-1), (MS-ESS3-1); HS.LS2.B (MS-ESS2-1), HS.ESS2.A (MS-ESS2-1), (MS-ESS2-4), (MS-ESS3-1); HS.ESS2.B (MS-ESS2-1), HS.ESS2.C (MS-ESS2-1), (MS-ESS2-4), (MS-ESS3-1); HS.ESS2.D (MS-ESS2-1), HS.ESS2.E (MS-ESS2-1); HS.ESS3.A (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)

Energy and Matter
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)

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)

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)

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-ESS3-1)
6-8.RST.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-ESS3-1)
6-8.RST.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (MS-ESS3-1)
8.5L.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-ESS2-1)

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-ESS3-1)
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-ESS3-1)

*Connection boxes updated as of September 2018

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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.

Science and Engineering Practices

**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 distribution. Emphasis is on the sun-driven, mostly 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 convection 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.]

**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 temperatures and currents, are major determinants of local weather patterns. (MS-Ess2-5)
- Variations in density due to variations in temperature and salinity drive a global 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 depend on 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 current 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)

**Connections to other DCIs in this grade-band:** MS.PS.1.A (MS-Ess2-5); MS.PS.2.A (MS-Ess2-5), (MS-Ess2-6); MS.PS.3.A (MS-Ess2-5), (MS-Ess3-5); MS.PS.3.B (MS-Ess2-5), (MS-Ess2-6), (MS-Ess3-5); MS.PS.4.B (MS-Ess2-6); MS.PS.5.D.1 (MS-Ess2-6), (MS-Ess3-5); MS.PS.5.D.4 (MS-Ess2-6); MS.PS.5.D.6 (MS-Ess2-5), (MS-Ess3-5); MS.Ess2.D.1 (MS-Ess2-5), (MS-Ess2-6); MS.Ess2.D.2 (MS-Ess2-5), (MS-Ess2-6); MS.Ess2.D.3 (MS-Ess2-5); MS.Ess3.D.1 (MS-Ess2-5), (MS-Ess3-5); MS.Ess3.D.2 (MS-Ess2-5), (MS-Ess2-6); MS.Ess3.D.3 (MS-Ess2-5), (MS-Ess3-5).

**Articulation of DCIs across grade-bands:** **3.ESS2.A (MS-Ess2-6), 3.ESS2.B (MS-Ess2-6), 3.ESS2.D (MS-Ess2-6), 5.ESS2.A (MS-Ess2-5), (MS-Ess2-6), 5.ESS2.B (MS-Ess2-6), 5.ESS2.D (MS-Ess2-6);**
**HS.PS3.A.1 (MS-Ess2-6); HS.PS3.A.5 (MS-Ess2-6); HS.PS3.B (MS-Ess2-5), (MS-Ess2-6); HS.PS3.C (MS-Ess2-5), (MS-Ess2-6); HS.PS3.D (MS-Ess2-5), (MS-Ess3-5), (MS-Ess3-6); HS.PS3.E (MS-Ess2-5), (MS-Ess2-6); HS.PS3.F (MS-Ess2-5), (MS-Ess2-6).**

**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).

- **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-Ess2-6).

- **8.L.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).

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

MS. Human Impacts

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 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 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.]

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**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)

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**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)

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**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 correlational, 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)

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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-ESS3-4)
- The uses of technologies and their 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)

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**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)

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New York State Next Generation Learning Standards: ELA/ALP

- **6.B.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-ESS3-2, MS-ESS3-4)

- **6.B.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-ESS3-2)

- **6.B.WHST.1**
  - Write arguments focused on discipline content. (MS-ESS3-4)

- **6.B.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-ESS3-3)

- **6.B.WHST.8**
  - Gather relevant information from multiple print and digital sources, using search terms effectively, assess the credibility and accuracy of each source, and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS3-3)

- **6.B.WHST.9**
  - Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-4)

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<table>
<thead>
<tr>
<th>Mathematics –</th>
<th>Reason abstractly and quantitatively. (MS-ESS3-2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NY-6.RP.1</strong></td>
<td>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></td>
<td>Recognize and represent proportional relationships between quantities. (MS-PS4-1)</td>
</tr>
<tr>
<td><strong>NY-6.EE.6</strong></td>
<td>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></td>
<td>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

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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.

### 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)
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3)
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-1), (MS-ETS1-3)
- Models of all kinds are important for testing solutions. (MSET1-4)

#### 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)
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)

### Science and Engineering Practices

#### Asking Questions and Defining Problems
- Asking questions and defining problems in grades 6-8 builds on grades K-5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.
  - Define a design problem that can be solved through the development of an object, tool, or process. (MS-ETS1-1)

#### Developing and Using Models
- Modeling 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 world and designed world.

#### Analyzing and Interpreting Data
- Analyzing data 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 world and designed world.
  - Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)

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

### Crosscutting Concepts

- 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-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)

### 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-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 presented 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** Draw evidence from literary or informational texts to support analysis, reflection, and research. (MS-ETS1-2)
- **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-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)

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