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).
P. Life Sciences

**Science and Engineering Practices**

Developing and Using Models
- Modeling in PK–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.
  - Compare models to identify common features and differences. (P-LS3-1)
  - Develop a simple model based on evidence to represent a proposed object or tool. (P-LS3-1)

Planning and Carrying Out Investigations
- Planning and carrying out investigations to answer questions or test solutions to problems in PK–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
  - With guidance, plan and conduct an investigation in collaboration with peers. (P-LS1-2)

Analyzing and Interpreting Data
- Analyzing data in PK–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
  - Record information (observations, thoughts, and ideas). (P-LS1-1)
  - Analyze data from tests of an object or tool to determine if it works as intended. (P-PS2-1)

Obtaining, Evaluating, and Communicating Information
- Obtaining, evaluating, and communicating information in PK–2 builds on prior experiences and uses observations and texts to communicate new information.
  - Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas. (P-LS1-1)

**Disciplinary Core Ideas**

**LS1.A: Structure and Function**
- All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (P-LS1-2)

**LS1.C: Organization for Matter and Energy Flow in Organisms**
- (NYSED) All animals need food, air, and water in order to live, grow, and thrive. Animals obtain food from plants or from other animals. Plants need water, air, and light to live, grow, and thrive. (P-LS1-1)

**LS1.D: Information Processing**
- Animals and plants respond to different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (P-LS1-2)

**LS3.A: Inheritance of Traits**
- (NYSED) Some young animals are similar to, but not exactly, like their parents. Some young plants are also similar to, but not exactly, like their parents. (P-LS3-1)

**LS3.B: Variation of Traits**
- Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (P-LS1-1)

**Connections to Nature of Science**

**Scientific Investigations Use a Variety of Methods**
- Scientists use different ways to study the world. (P-LS1-2)

**Crosscutting Concepts**

**Patterns**
- Patterns in the natural and designed world can be observed and used as evidence. (P-LS1-1), (P-LS3-1)

**Cause and Effect**
- Events have causes that generate observable patterns. (P-LS1-2)

**Systems and System Models**
- Systems in the natural and designed world have parts that work together. (P-LS1-2)

**Structure and Function**
- The shape and stability of structures of natural and designed objects are related to their function(s). (P-LS1-2)

*Connections to other DCIs in prekindergarten: P.ESS2.D (P-LS1-1); P.PS3.B (P-LS1-2)

Articulation of DCIs across grades K–2:
- KL.S1.C (P-LS1-1); K.ESS3.C (P-LS1-1); P-LS1.A (P-LS1-1); L.S1.A (P-LS1-1); L.S1.D (P-LS1-2); L.S3.A (P-LS3-1); L.S3.B (P-LS3-1)

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

**ELA/Literacy-**
- PKR1 Participate in discussions about a text. (P-LS1-1), (P-LS1-2), (P-LS3-1)
- PKR4 Exhibit an interest in learning new vocabulary. (P-LS1-1), (P-LS1-2), (P-LS3-1)
- PKW1 Use a combination of drawing, dictating, oral expression, and/or emergent writing to state an opinion about a familiar topic in child-centered, authentic, play-based learning. (P-LS1-1), (P-LS1-2), (P-LS3-1)
- PKW2 Use a combination of drawing, dictating, oral expression, and/or emergent writing to name a familiar topic and supply information in child-centered, authentic, play-based learning. (P-LS1-1), (P-LS1-2), (P-LS3-1)
- PKW3 Use a combination of drawing, dictating, oral expression, and/or emergent writing to narrate an event or events in a sequence. (P-PS1-1), (P-PS2-1), (P-PS4-1)
- PKW7 Engage in a discussion using gathered information from experiences or provided resources. (P-LS1-1), (P-LS1-2), (P-LS3-1)
- PKSL2 Interact with diverse formats and texts. (P-LS1-1), (P-LS1-2), (P-LS3-1)
- PKS3 Identify the speaker. (P-LS1-1), (P-LS1-2), (P-LS3-1)
- PKS5 Create a visual display. (P-LS1-1), (P-LS1-2), (P-LS3-1)

**Mathematics-**
- MP.1 Make sense of problems and persevere in solving them. (P-LS1-1), (P-LS3-1)
- MP.5 Use appropriate tools strategically. (P-LS1-1), (P-LS1-2), (P-LS3-1)

**NY-PK.OA.2**
- Duplicate and extend (e.g., What comes next?) simple patterns using concrete objects. (P-LS1-2), (P-LS3-1)

**NY-PK.MD.1**
- Identify measurable attributes of objects, such as length, and weight. Describe them using correct vocabulary (e.g., small, big, short, tall, empty, full, heavy, and light). (P-LS1-1), (P-LS1-2), (P-LS3-1)

**NY-PK.MD.2**
- Sort objects into categories; count the numbers of objects in each category. 1 (limit category counts to be less than or equal to 10) (P-LS3-1)

*Connection boxes updated as of September 2018*
### Science and Engineering Practices

**Asking Questions and Defining Problems**  
Asking questions and defining problems in grades PK–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.  
- **PKSL1** Analyze and interpret data  
- **PKSL2** Plan and conduct investigations to answer questions or test solutions to problems in grades PK–2; build on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.  
- **PKSL3** Gather and interpret data from tests of an object or tool to determine if they work as intended.

**Planning and Carrying Out Investigations**  
Planning and carrying out investigations to answer questions or test solutions in grades PK–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.  
- **PKW1** Engages in guided discussions to share data and ideas with peers.  
- **PKW2** Uses observations (firsthand or from media) to collect data that can be used to make comparisons.  
- **PKW3** Analyzes data in grade PK–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.  
- **PKW4** Analyzes patterns in the natural world in order to answer scientific questions.  
- **PKW5** Analyzes data from tests of an object or tool to determine if they work as intended.

**Analyzing and Interpreting Data**  
Analyzing data in grade PK–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.  
- **PKW6** Uses observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.  
- **PKW7** Analyzes data from tests of an object or tool to determine if they work as intended.

### Disciplinary Core Ideas

**PS3.B: Conservation of Energy and Energy Transfer**  
- **Sunlight warms Earth’s surface**  
- **Objects can be seen if light is available to illuminate them or if they give off their own light.**

**ESS1.A: The Universe and its Stars**  
- **Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.**

**ESS1.B: Earth and the Solar System**  
- **Seasonal patterns of sunrise and sunset can be observed, described, and predicted.**

**ESS2.D: Weather and Climate**  
- **Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time.**

**ESS3.B: Natural Hazards**  
- **Some kinds of severe weather are more likely than others in a given region.**

### Crosscutting Concepts

**Patterns**  
- **Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.**

**Cause and Effect**  
- **Simple tests can be designed to gather evidence to support or refute student ideas about causes.**

### Connections to Nature of Science

**Science Investigations Use a Variety of Methods**  
- Scientists use different ways to study the world.

**Connections to Other DCIs in Kindergarten**  
- **PKS2.A** (P-ESS1-1)

**Articulation of DCIs across Grades K–1**  
- **K.PS3.B** (P-ESS3-1); **K.ESS2.D** (P-ESS2-1); **K.ESS3.B** (P-ESS3-1); **1.ESS1.A** (P-ESS1-1); **1.ESS1.B** (P-ESS1-1); **1.ESS2-1); **1.ESS3-1); **1.ESS3.B** (P-ESS3-1)

**NY State Next Generation Learning Standards Connections:**

**ELA/Literacy –**
- **PKR1** Participate in discussions about a text.  
- **PKR4** Exhibit an interest in learning new vocabulary.  
- **PKR5** Use a combination of drawing, dictating, oral expression, and/or emergent writing to name a familiar topic and supply information in child-centered, authentic, play-based learning.  
- **PKW2** Engage in a discussion using gathered information from experiences or provided resources.  
- **PKW7** Create a visual display.

**Mathematics –**
- **MP.1** Make sense of problems and persevere in solving them.
- **MP.5** Use appropriate tools strategically.

**NY.PK.CC.5** Identify whether the number of objects in one group is more, less, greater than, fewer, and/or equal to the number of objects in another group, e.g., by using matching and counting strategies.  
- **NY.PK.G.1** Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as top, bottom, up, down, in front of, behind, over, under, and next to.

**NY.PK.OA.2** Duplicate and extend (e.g., What comes next?) simple patterns using concrete objects.

**NY.PK.G.3** Analyze, compare, and sort two- and three-dimensional shapes and objects, in different sizes, using informal language to describe their similarities, differences, and other attributes (e.g., color, size, and shape).

**NY.PK.G.4** Create and build shapes from components (e.g., sticks and clay balls).

*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).*
### K. Matter and Its Interactions

**K-PS1-1.** Plan and conduct an investigation to test the claim that different kinds of matter exist as either solid or liquid, depending on temperature.  
[Clarification Statement: Emphasis should be on solids and liquids at a given temperature and that a solid may be a liquid at higher temperature and a liquid may be a solid at a lower temperature. ]  
[Assessment Boundary: Only a qualitative description of temperature, such as hot, warm, and cool, is expected]

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

**Planning and Carrying Out Investigation**
PLAN and conduct an investigation to answer questions or test solutions to problems in K-2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
- With guidance, plan and conduct an investigation in collaboration with peers. (K-PS1-1)

**Analyzing and Interpreting Data**
Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations.
- Record information (observations, thoughts, and ideas). (K-PS1-1)
- Analyze data from tests of an object or tool to determine if it works as intended. (K-PS1-1)

### Disciplinary Core Ideas

**PS1.A: Structure and Properties of Matter**
- Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (K-PS1-1)

### Crosscutting Concepts

**Cause and Effect**
- Simple tests can be designed to gather evidence to support or refute student ideas about causes. (K-PS1-1)

**Energy and Matter**
- Students observe objects may break into smaller pieces, be put together into larger pieces, or change shapes. (K-PS1-1)

*Connections to Nature of Science*

**Scientific Investigations Use a Variety of Methods**
- Scientists use different ways to study the world. (K-PS1-1)

*Connections to other DCIs in kindergarten: K.ETS1.A (K-PS2-2); K.ETS1.B (K-PS2-2)*

*Articulation of DCIs across grade-levels: 2.ETS1.B (K-PS2-2); 3.PS2.A (K-PS2-1), (K-PS2-2); 3.PS2.B (K-PS2-1); 4.PS3.A (K-PS2-1); 4.ETS1.A (K-PS2-2)*

*New York State Next Generation Learning Standards*

**Connections:**
- **ELA/Literacy** -
  - KR1: Develop and answer questions about a text. (K-PS1-1)
  - KW6: Develop questions and participate in shared research and exploration to answer questions and to build and share knowledge. (K-PS1-1)
  - KSL3: Develop and answer questions to clarify what the speaker says. (K-PS1-1)

**Mathematics** -
- MP.2: Reason abstractly and quantitatively. (K-PS1-1)
- NY-K.MD.1: Describe measurable attributes of object(s), such as length or weight, using appropriate vocabulary. (K-PS1-1)
- NY-K.MD.2: Directly compare two objects with a common measurable attribute and describe the difference. (K-PS1-1)

*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).*
### Science and Engineering Practices

**Planning and Carrying Out Investigations**
- Planning and carrying out investigations to answer questions or test solutions to problems in K-2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
- With guidance, plan and conduct an investigation in collaboration with peers. (K-PS2-1)

**Analyzing and Interpreting Data**
- Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations.
- Analyze data from tests of an object or tool to determine if it works as intended. (K-PS2-2)

**Connections to Nature of Science**
- Scientists use different ways to study the world. (K-PS2-1)

### Disciplinary Core Ideas

**PS2.A: Forces and Motion**
- Pushes and pulls can have different strengths and directions. (K-PS2-1), (K-PS2-2)
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1), (K-PS2-2)

**PS2.B: Types of Interactions**
- When objects touch or collide, they push on one another and can change motion. (K-PS2-1)

**PS3.C: Relationship Between Energy and Forces**
- A bigger push or pull makes things speed up or slow down more quickly. (secondary to K-PS2-1)

### Crosscutting Concepts

**Cause and Effect**
- Simple tests can be designed to gather evidence to support or refute student ideas about causes. (K-PS2-1), (K-PS2-2)

### New York State Next Generation Learning Standards Connections

**ELA/Literacy -**
- **K.R1** Develop and answer questions about a topic. (K-PS2-2)
- **K.W.6** Develop questions and participate in research and exploration to answer questions and to build and share knowledge. (K-PS2-1)
- **K.SL.3** Develop and answer questions to clarify what the speaker says. (K-PS2-2)
- **MP.2** Reason abstractly and quantitatively. (K-PS2-1)

**Mathematics -**
- **NY.K.MD.1** Describe measurable attributes of objects, such as length or weight, using appropriate vocabulary. (K-PS2-1)
- **NY.K.MD.2** Directly compare two objects with a common measurable attribute and describe the difference. (K-PS2-1)

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

**K. Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment**

Students who demonstrate understanding can:

**K-LS1-1.** Use observations to describe patterns of what plants and animals (including humans) need to survive. [Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and that all living things need water and other materials to live, grow, and thrive.]

**K-ESS2-2.** Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. [Clarification Statement: Examples of plants and animals changing their environment could include a squirrel digging in the ground to hide its food and tree roots can break concrete.]

**K-ESS3-1.** Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. [Clarification Statement: Examples of relationships could include that deer eat buds and leaves, therefore, they usually live in forested areas, and grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system.]

**K-ESS3-3.** Communicate solutions that will reduce the impact of humans on living organisms and non-living things in the local environment. * [Clarification Statement: Examples of human impact on the environment (land, water, air, plants, and animals) could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.]

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>Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diagram, dramatization, or storyboard) that represent concrete events or design solutions.</td>
<td></td>
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<tr>
<td>• Use a model to represent relationships in the natural world. (K-ESS3-1)</td>
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<tr>
<td><strong>Analyzing and Interpreting Data</strong></td>
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<td>• Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-LS1-1)</td>
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<tr>
<td><strong>Engaging in Argument from Evidence</strong></td>
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<tr>
<td>Engaging in argument from evidence in K-2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).</td>
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<tr>
<td>• Construct an argument with evidence to support a claim. (K-ESS2-2)</td>
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<tr>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
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<td>• Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas. (K-ESS3-3)</td>
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**Connections to Nature of Science**

**Scientific Knowledge is Based on Empirical Evidence**

• Scientists look for patterns and order when making observations about the world. (K-LS1-1)

**Connections to other DCIs in kindergarten:** 1.ETS1.A (K-ESS3-3)

**Articulation of DCIs across grade levels:** 1.LS1.A (K-LS1-1),(K-ESS3-1); 2.LS2.A (K-LS1-1); 2.ESS2.A (K-ESS3-3); 3.LS2.C (K-LS1-1); 3.LS4.B (K-LS1-1); 4.ESS2.E (K-ESS2-2); 1.K.ETS1.A (K-ESS3-3)

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

**ELA/Literacy**

**KR1** Develop and answer questions about a text. (K-ESS2-2)

**KW1** Use a combination of drawing, dictating, oral expression and/or emergent writing to state an opinion pieces about a familiar topic, personal experience and state a reason to support that topic. (K-ESS2-2)

**KW2** Use a combination of drawing, dictating, oral expression, and/or emergent writing to name a familiar topic and supply information. (K-ESS2-2),(K-ESS2-3)

**KW7** Develop questions and participate in shared research and exploration to answer questions and to build and share knowledge. (K-LS1-1)

**KSL5** Create and/or utilize existing visual displays to support descriptions. (K-ESS3-1)

**Mathematics**

**MP.2** Reason abstractly and quantitatively. (K-ESS3-1)

**MP.4** Model with mathematics. (K-ESS3-1)

**NY-K.CC** Counting and Cardinality (K-ESS3-1)

**NY-K-MD.2** Directly compare two objects with a common measurable attribute and describe the difference. (K-LS1-1)

*Connection boxes updated as of September 2018*

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K. Weather and Climate

Students who demonstrate understanding can:

K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time. [Clarification Statement: Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [Assessment Boundary: Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.]

K-ESS2-2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.* [Clarification Statement: Emphasis is on local forms of severe weather and local resources available for preparedness measures.]

K-PS3-1. Make observations to determine the effect of sunlight on Earth’s surface. [Clarification Statement: Examples of Earth’s surface could include sand, soil, rocks, and water. Assessment Boundary: Assessment of temperature is limited to relative measures such as warmer/cooler.]

K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.* [Clarification Statement: Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the sun.]

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

### Science and Engineering Practices

**Asking Questions and Defining Problems**
- Ask questions based on observations to find more information about the designed world. (K-ESS3-2)

**Planning and Carrying Out Investigations**
- Planning and carrying out investigations to answer questions or test solutions to problems in K-2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
  - Make observations (firsthand or from media) to collect data that can be used to make comparisons. (K-PS3-1)

**Analyzing and Interpreting Data**
- Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations.
  - Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-ESS1-2)

**Constructing Explanations and Designing Solutions**
- Constructing explanations and designing solutions in K-2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.
  - Use tools and materials provided to design and build a device that solves a specific problem or a solution to a specific problem. (K-PS3-2)

**Obtaining, Evaluating, and Communicating Information**
- Obtaining, evaluating, and communicating information in K-2 builds on prior experiences and uses observations and texts to communicate new information.
  - Read grade-appropriate texts and/or use media to obtain scientific information to describe patterns in the natural world.

**Connections to Nature of Science**
- Scientists use different ways to study the world. (K-PS3-1)

**Science Knowledge is Based on Empirical Evidence**
- Scientists look for patterns and order when making observations about the world. (K-ESS3-2)

### Disciplinary Core Ideas

**PS3.B: Conservation of Energy and Energy Transfer**
- Sunlight warms Earth’s surface. (K-PS3-1), (K-PS3-2)

**ESS2.D: Weather and Climate**
- Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (K-ESS2-1)

**ESS3.B: Natural Hazards**
- Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. (K-ESS3-2)

**ETS1.A: Defining and Delimiting an Engineering Problem**
- Asking questions, making observations, and gathering information are helpful in thinking about problems. (secondary to K-ESS3-2)

### Crosscutting Concepts

**Patterns**
- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (K-ESS2-1)

**Cause and Effect**
- Events have causes that generate observable patterns. (K-PS3-1), (K-PS3-2), (K-ESS3-2)

**Connections to Engineering, Technology, and Applications of Science**
- Interdependence of Science, Engineering, and Technology
  - People depend on various technologies in their lives; human life would be very different without technology. (K-ESS3-2)

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## New York State P-12 Science Learning Standards

### Articulation of DCIs across grade-levels:

<table>
<thead>
<tr>
<th>DCI</th>
<th>Grade Levels</th>
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<tbody>
<tr>
<td>1.PS4.B</td>
<td>(K-PS3-1),(K-PS3-2)</td>
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<tr>
<td>2.ESS1.C</td>
<td>(K-ESS3-2)</td>
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<td>2.ESS2.A</td>
<td>(K-ESS2-1)</td>
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<tr>
<td>2.ETS1.B</td>
<td>(K-PS3-2)</td>
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<tr>
<td>3.ESS3.B</td>
<td>(K-PS3-2); 3.ESS3.B</td>
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### New York State Next Generation Learning Standards Connections:

**ELA/Literacy**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>KR1</td>
<td>Develop and answer questions about a text. (K-ESS3-2)</td>
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<tr>
<td>KW6</td>
<td>Develop questions and participate in shared research and exploration to answer questions and to build and share knowledge. (K-PS3-1),(K-PS3-2),(K-ESS2-1)</td>
</tr>
<tr>
<td>KSL3</td>
<td>Develop and answer questions to clarify what the speaker says. (K-ESS3-2)</td>
</tr>
</tbody>
</table>

**Mathematics**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP.2</td>
<td>Reason abstractly and quantitatively. (K-ESS2-1)</td>
</tr>
<tr>
<td>MP.4</td>
<td>Model with mathematics. (K-ESS2-1),(K-ESS3-2)</td>
</tr>
<tr>
<td>NY-K.CC</td>
<td>Counting and Cardinality (K-ESS2-1),(K-ESS3-2)</td>
</tr>
<tr>
<td>NY-K.MD.1</td>
<td>Describe measurable attributes of objects, such as length or weight, using appropriate vocabulary. (K-ESS2-1)</td>
</tr>
<tr>
<td>NY-K.MD.2</td>
<td>Directly compare two objects with a common measurable attribute and describe the difference. (K-PS3-1),(K-PS3-2)</td>
</tr>
<tr>
<td>NY-K.MD.3</td>
<td>Classify objects into given categories; count the objects in each category and sort the categories by count. (K-ESS2-1)</td>
</tr>
</tbody>
</table>

*Connection boxes updated as of September 2018

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

#### 1. Waves: Light and Sound

- **1-PS4-1.** Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. [Clarification Statement: Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.]

- **1-PS4-2.** Make observations (firsthand or from media) to construct an evidence-based account that objects can be seen only when illuminated. [Clarification Statement: Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light.]

- **1-PS4-3.** Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light. [Clarification Statement: Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror). [Assessment Boundary: Assessment does not include the speed of light.]

- **1-PS4-4.** Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.* [Clarification Statement: Examples of devices could include a light source to send signals, paper cup and string “telephones,” and a pattern of drum beats.] [Assessment Boundary: Assessment does not include technological details for how communication devices work.]

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### Science and Engineering Practices

#### Planning and Carrying Out Investigations

- Plan and conduct investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
  - **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.
    - Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena (1-PS4–2)
    - Use tools and materials provided to design a device that solves a specific problem. (1-PS4–4)

#### Scientific Investigations Use a Variety of Methods

- Science investigations begin with a question. (1-PS4–1)
- Scientists use different ways to study the world. (1-PS4–4)

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### Disciplinary Core Ideas

- **PS4.A: Wave Properties**
  - Sound can make matter vibrate, and vibrating matter can make sound. (1-PS4–1)

- **PS4.B: Electromagnetic Radiation**
  - Objects can be seen if light is available to illuminate them or if they give off their own light. (1-PS4–2)
  - Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (Boundary: The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.) (1-PS4–3)

- **PS4.C: Information Technologies and Instrumentation**
  - People also use a variety of devices to communicate (send and receive information) over long distances. (1-PS4–4)

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### Crosscutting Concepts

- **Cause and Effect**
  - Simple tests can be designed to gather evidence to support or refute student ideas about causes. (1-PS4–1),(1-PS4–2),(1-PS4–3)

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

- Influence of Engineering, Technology, and Science, on Society and the Natural World
  - People depend on various technologies in their lives; human life would be very different without technology. (1-PS4–4)

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### Articulation of DCIs across grade-levels

- **K.ETLS1A (1-PS4–4); 2.PS1.A (1-PS4–3); 2.ETS1.B (1-PS4–4); 4.PS4.C (1-PS4–4); 4.PS4.B (1-PS4–2); 4.ETS1.A (1-PS4–4)**

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

- **ELA/Literacy:**
  - **1W2** Write an informative/explanatory text to introduce a topic, supplying some facts to develop points, and provide some sense of closure. (1-PS4–2),(1-PS4–3),(1-PS4–4)
  - **1W6** Develop questions and participate in shared research and explorations to answer questions and to build knowledge. (1-PS4–1),(1-PS4–2),(1-PS4–3)
  - **1W7** Recall and represent relevant information from experiences or gather information from provided sources to answer a question in a variety of ways. (1-PS4–1),(1-PS4–2),(1-PS4–3)

- **Mathematics:**
  - **MP.5** Use appropriate tools strategically. (1-PS4–4)
  - **NY-1.MD.1** Order three objects by length; compare the lengths of two objects indirectly by using a third object. (1-PS4–4)
  - **NY-1.MD.2** Measure the length of an object using same-size “length units” placed end to end with no gaps or overlaps. Express the length of an object as a whole number of “length units”. (1-PS4–4)

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

**1. Structure, Function, and Information Processing**

Students who demonstrate understanding can:

1. **LS1-1.** Use materials to design a solution to a human problem by mimicking how plants and/ or animals use their external parts to help them survive, grow, and meet their needs.*
   - **Clarification Statement:** Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.

2. **LS1-2.** Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. *(Clarification Statement: Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).)*

3. **LS3-1.** Make observations to construct an evidence-based account that some young plants and animals are similar to, but not exactly like, their parents. *(Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size, and, a particular breed of dog looks like its parents but is not exactly the same.)*

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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</thead>
<tbody>
<tr>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td><strong>LS1.A: Structure and Function</strong></td>
<td><strong>Patterns</strong></td>
</tr>
<tr>
<td>Constructing explanations and designing solutions in K-2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.</td>
<td>All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)</td>
<td><strong>Patterns</strong></td>
</tr>
<tr>
<td>- Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)</td>
<td><strong>LS1.B: Growth and Development of Organisms</strong></td>
<td><strong>Structure and Function</strong></td>
</tr>
<tr>
<td>- Use materials to design a device that solves a specific problem or a solution to a specific problem. (1-LS1-1)</td>
<td>Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2)</td>
<td><strong>The shape and stability of structures of natural and designed objects are related to their function(s). (1-LS1-1)</strong></td>
</tr>
<tr>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
<td><strong>LS1.D: Information Processing</strong></td>
<td><strong>Connections to Engineering, Technology and Applications of Science</strong></td>
</tr>
<tr>
<td>Obtaining, evaluating, and communicating information in K-2 builds on prior experiences and uses observations and texts to communicate new information.</td>
<td>Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (1-LS1-1)</td>
<td><strong>Influence of Engineering, Technology, and Science on Society and the Natural World</strong></td>
</tr>
<tr>
<td>- Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world. (1-LS1-2)</td>
<td><strong>LS3.A: Inheritance of Traits</strong></td>
<td><strong>Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world.</strong></td>
</tr>
<tr>
<td><strong>Connections to Nature of Science</strong></td>
<td><strong>LS3.B: Variation of Traits</strong></td>
<td>(1-LS1-1)</td>
</tr>
<tr>
<td>Science Knowledge is Based on Empirical Evidence</td>
<td>- Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)</td>
<td></td>
</tr>
</tbody>
</table>

**Connections to other DCIs in first grade:** N/A

**Articulation of DCIs across grade-levels:** K.ETS1.A (1-LS1-1); 3.LS2.D (1-LS1-2) 3.LS3.A (1-LS3-1); 3.LS3.B (1-LS1-1); 4.LS1.A (1-LS1-1); 4.LS1.D (1-LS1-1); 4.ETS1.A (1-LS1-1)

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

- **ELA/Literacy:**
  - 1.R1 Develop and answer questions about key ideas and details in a text. (1-LS1-2); (1-LS3-1)
  - 1.R2 Identify a main topic or idea in a text and retell important details. (1-LS1-2)
  - 1.W6 Develop questions and participate in shared research and explorations to answer questions and to build knowledge. (1-PS4-1); (1-PS4-2); (1-PS4-3); (1-PS4-4)
  - 1.W7 Recall and represent information from experiences or gather information from provided sources to answer a question. (1-LS3-1)

- **Mathematics:**
  - MP.2 Reason abstractly and quantitatively. (1-LS3-1)
  - MP.5 Use appropriate tools strategically. (1-LS3-1)

- **NY-1.NBT.3** Compare two two-digit numbers based on the meanings of the tens and one digits, recording the results of comparisons with the symbols >, =, and <. (1-LS1-2)

- **NY-1.NBT.4** Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10. Use concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction. Understand that in adding two-digit numbers, one adds tens and tens, ones and ones; and sometimes it is necessary to compose a ten. Relate the strategy to a written method and explain the reasoning. (1-LS1-2)

- **NY-1.NBT.5** Given a two-digit number, mentally find 10 more or 10 less than the number, without having to count; explain the reasoning used. (1-LS1-2)

- **NY-1.NBT.6** Subtract multiples of 10 from the range 10-90 from multiples of 10 in the range 10-90 using concrete models or drawings, and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction. Relate the strategy to a written method and explain the reasoning used. (1-LS1-2)

- **NY-1.MD.1** Order three objects by length; compare the lengths of two objects indirectly by using a third object. (1-LS3-1)

*Connection boxes updated as of September 2018*

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### 1. Space Systems: Patterns and Cycles

**1-ESS1-1. Use observations of the Sun, moon, and stars to describe patterns that can be predicted.** [Clarification Statement: Examples of patterns could include that the Sun and moon appear to rise along the eastern horizon, move in a predictable pathway across the sky, and set along the western horizon; and stars other than our Sun are visible at night depending on weather and other conditions such as light pollution but not visible during the day.] [Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.]

**1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year.** [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] [Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]

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### Science and Engineering Practices

**Planning and Carrying Out Investigations**

Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- Make observations (firsthand or from media) to collect data that can be used to make comparisons. (1-ESS1-2)

**Analyzing and Interpreting Data**

Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (1-ESS1-1)

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### Disciplinary Core Ideas

**ESS1.A: The Universe and its Stars**

- Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (1-ESS1-1)

**ESS1.B: Earth and the Solar System**

- Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2)

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### Crosscutting Concepts

**Patterns**

- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-ESS1-1, 1-ESS1-2)

**Connections to Nature of Science**

- Science assumes natural events happen today as they happened in the past. (1-ESS1-1)
- Many events are repeated. (1-ESS1-1)

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### Connections to other DCIs in first grade: N/A

### Articulation of DCIs across grade levels:

- 3.PS2.A (1-ESS1-1), 5.PS2.B (1-ESS1-1), (1-ESS1-2)
- 5-ESS1.B (1-ESS1-1), (1-ESS1-2)

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

**ELA/Literacy –**

- 1W6 Develop questions and participate in shared research and explorations to answer questions and to build knowledge. (1-ESS1-1), (1-ESS1-2)

**Mathematics –**

- MP.2 Reason abstractly and quantitatively. (1-ESS1-2)
- MP.4 Model with mathematics. (1-ESS1-2)
- MP.5 Use appropriate tools strategically. (1-ESS1-2)
- NY-1.OA.1 Use addition and subtraction within 20 to solve one step word problems involving situations of adding to, taking from, putting together, taking apart, and/or comparing, with unknowns in all positions. (1-ESS1-2)
- NY-1.MD.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another. (1-ESS1-2)

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

**2. Structure and Properties of Matter**

Students who demonstrate understanding can:

2-PS1-1. **Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.** [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]

2-PS1-2. **Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.** [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency. Assessment Boundary: Assessment of quantitative measurements is limited to length.]

2-PS1-3. **Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.** [Clarification Statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.]

2-PS1-4. **Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.** [Clarification Statement: An example of a reversible change could include freezing and melting. An example of an irreversible change could include cooking an egg.]

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### Science and Engineering Practices

<table>
<thead>
<tr>
<th>Planning and Carrying Out Investigations</th>
<th>Analyzing and Interpreting Data</th>
<th>Constructing Explanations and Designing Solutions</th>
<th>Engaging in Argument from Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.</td>
<td>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.</td>
<td>Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.</td>
<td>Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).</td>
</tr>
</tbody>
</table>

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### Disciplinary Core Ideas

**PSL.A: Structure and Properties of Matter**

- Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)
- Different properties are suited to different purposes. (2-PS1-2),(2-PS1-3)
- A great variety of objects can be built up from a small set of pieces. (2-PS1-3)

**PSL.B: Chemical Reactions**

- Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)

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### Crosscutting Concepts

- **Patterns**
  - Patterns in the natural and human designed world can be observed. (2-PS1-1)

- **Cause and Effect**
  - Events have causes that generate observable patterns. (2-PS1-4)
  - Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2)

- **Energy and Matter**
  - Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-3)

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

- Influence of Engineering, Technology, and Science on Society and the Natural World
  - Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural

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**Articulation of DCIs across grade-levels:**

- 4.ESS2.A (2-PS1-3); 5.PS1.A (2-PS1-1),(2-PS1-2),(2-PS1-3); 5.PS1.B (2-PS1-4); 5.LS2.A (2-PS1-3)

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

**ELA/Literacy –**

- **2.R1** Develop and answer questions to demonstrate an understanding of key ideas and details in a text. (2-PS1-4)
- **2.R3** In informational texts, describe the connections among ideas, concepts, or a series of events. (2-PS1-4)
- **2.R8** Explain how specific points the author or illustrator makes in a text are supported by relevant reasons. (2-PS1-2),(2-PS1-4)
- **2.W1** Write an opinion about a topic or personal experience, using clear reasons and relevant evidence. Please note: Students in 2nd grade should understand the difference between opinions and arguments and begin to learn how to write arguments with claims and supporting reasons. (2-PS1-4)
- **2.W6** Develop questions and participate in shared research and explorations to answer questions and to build knowledge. (2-PS1-1), (2-PS1-2), (2-PS1-3)
- **2.W7** Recall and represent relevant information from experiences or gather information from provided sources to answer a question. (2-PS1-1),(2-PS1-2),(2-PS1-3)

**Mathematics –**

- **MP.2** Reason abstractly and quantitatively. (2-PS1-2)
- **MP.4** Model with mathematics. (2-PS1-1),(2-PS1-2)
- **MP.5** Use appropriate tools strategically. (2-PS1-2)
- **NY-2.MD.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a picture graph or a bar graph. (2-PS1-1),(2-PS1-2)

*Connection boxes updated as of September 2018

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New York State P-12 Science Learning Standards

2. Interdependent Relationships in Ecosystems

Students who demonstrate understanding can:

2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow. [Assessment Boundary: Assessment is limited to testing one variable at a time.]

2-LS2-2. Develop a simple model that illustrates how plants and animals depend on each other for survival.* [Clarification Statement: Examples could include animals dispersing seeds or pollinating plants, and plants providing food, shelter, and other materials for animals.]

2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats. [Clarification Statement: Emphasis is on the diversity of living things in each of a variety of different habitats.] [Assessment Boundary: Assessment does not include specific animal and plant names in specific habitats.]

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### Science and Engineering Practices

Developing and Using Models
- Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.
  - Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2)

Planning and Carrying Out Investigations
- Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
  - Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1)
  - Make observations (firsthand or from media) to collect data that can be used to make comparisons. (2-LS4-1)

### Disciplinary Core Ideas

#### LS2.A: Interdependent Relationships in Ecosystems
- Animals depend on plants or other animals for food. (2-LS2-2)
- (NYSED) Plants depend on water, light and air to grow. (2-LS2-1)
- (NYSED) Some plants depend on animals for pollination and for dispersal of seeds from one location to another. (2-LS2-2)

#### LS4.D: Biodiversity and Humans
- There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)

#### ETS1.B: Developing Possible Solutions
- (NYSED) Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas to other people (secondary to 2-LS2-2)

### Crosscutting Concepts

#### Cause and Effect
- Events have causes that generate observable patterns. (2-LS2-1)

#### Structure and Function
- The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)

#### Patterns
- Similarities and differences in patterns can be used to sort and classify organisms. (2-LS4-1)

### Scientific Knowledge is Based on Empirical Evidence
- Scientists look for patterns and order when making observations about the world. (2-L5-1)

### Connections to Nature of Science

### Articulation of DCIs across grade levels:
- K.LS1.C (2-LS2-1); K-ESS3.A (2-LS2-1); K.ETS1.A (2-LS2-2); 3.LS4.C (2-LS4-1); 3.LS4.D (2-LS4-1); 5.LS1.C (2-LS2-1); 5.LS2.A (2-LS2-2), (2-LS4-1)

New York State Next Generation Learning Standards Connections:
- **ELA/Literacy** -
  - **2W6** Develop questions and participate in shared research and explorations to answer questions and to build knowledge. (2-LS2-1),(2-LS4-1)
  - **2W7** Recall and represent relevant information from experiences or gather information from provided sources to answer a question. (2-LS2-1),(2-LS4-1)

- **Mathematics** -
  - **MP.2** Reason abstractly and quantitatively. (2-LS2-1),(2-LS4-1)
  - **MP.4** Model with mathematics. (2-LS2-1),(2-LS2-2),(2-LS4-1)
  - **MP.5** Use appropriate tools strategically. (2-LS2-1)

- **NY-2.MD.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a picture graph or a bar graph. (2-LS2-2),(2-LS4-1)

*Connection boxes updated as of September 2018

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

#### 2. Earth's Systems: Processes that Shape the Earth

Students who demonstrate understanding can:

2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.

[Clarification Statement: Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly and weathering and erosion of rocks, which may occur slowly.]

2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. [Clarification Statement: Examples of solutions could include different designs for using rocks, shrubs, grass, and trees to hold back wind, water, and land.]

2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area. [Assessment Boundary: Assessment does not include quantitative measurements of timescales.]

2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.

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>
</tr>
</thead>
<tbody>
<tr>
<td>Developing and Using Models</td>
<td>2-ESS1-C: The History of Planet Earth</td>
</tr>
<tr>
<td>Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.</td>
<td>• Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)</td>
</tr>
<tr>
<td>• Develop a model to represent patterns in the natural world. (2-ESS2-2)</td>
<td>2-ESS2-A: Earth Materials and Systems</td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>• Wind and water can change the shape of the land. (2-ESS2-1)</td>
</tr>
<tr>
<td>Constructing explanations and designing solutions in K-2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.</td>
<td>2-ESS2-B: Plate Tectonics and Large-Scale System Interactions</td>
</tr>
<tr>
<td>• Make observations from several sources to construct an evidence-based account for natural phenomena. (2-ESS1-1)</td>
<td>• Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS2-2)</td>
</tr>
<tr>
<td>• Compare multiple solutions to a problem. (2-ESS2-1)</td>
<td>2-ESS2-C: The Roles of Water in Earth's Surface Processes</td>
</tr>
<tr>
<td>Obtaining, Evaluating, and Communicating Information</td>
<td>• Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. (2-ESS2-3)</td>
</tr>
<tr>
<td>Obtaining, evaluating, and communicating information in K-2 builds on prior experiences and uses observations and texts to communicate new information.</td>
<td>ETS1.C: Optimizing the Design Solution</td>
</tr>
<tr>
<td>• Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question. (2-ESS2-3)</td>
<td>• Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (secondary to 2-ESS2-1)</td>
</tr>
</tbody>
</table>

**Crosscutting Concepts**

- Patterns
  - • Patterns in the natural world can be observed. (2-ESS2-2), (2-ESS2-3)
- Stability and Change
  - • Things may change slowly or rapidly. (2-ESS1-1), (2-ESS2-1)

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

- Influence of Engineering, Technology, and Science on Society and the Natural World
  - • Developing and using technology has impacts on the natural world. (2-ESS2-1)

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

- • Scientists study the natural and material world. (2-ESS2-1)

**Connections to Nature of Science**

**Connections to other DCIs in second grade:** 2.PSL1.A (2-ESS2-3)

**Articulation of DCIs across grade-levels:**

- K.ETS1.A (2-ESS2-1); 3.LS2.C (2-ESS1-1); 4.ESS1.C (2-ESS1-1); 4.ESS2.A (2-ESS1-1), (2-ESS2-1); 4.ESS2.B (2-ESS2-2); 4.ESS2.C (2-ESS2-2); 4.ESS2.D (2-ESS2-2); 4.ESS2.E (2-ESS2-2); 5.ESS2.C (2-ESS2-2);

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

**ELA/Literacy**

- 2RI Develop and answer such questions to demonstrate understanding of key ideas and details in a text. (2-ESS1-1)
- 2R3 In literary texts, describe how characters respond to major events and challenges. (2-ESS1-1), (2-ESS2-1)
- 2W6 Develop questions and participate in shared research and explorations to answer questions and to build knowledge. (2-ESS1-1), (2-ESS1-1)
- 2W7 Recall and represent relevant information from experiences or gather information from provided sources to answer a question. (2-ESS1-1), (2-ESS2-3)
- 2SL2 Recount or describe key ideas or details of diverse texts and formats. (2-ESS1-1)
- 2SL5 Include digital media and/or visual displays in presentations to clarify or support ideas, thoughts, and feelings. (2-ESS2-2)

**Mathematics**

- MP.2 Reason abstractly and quantitatively. (2-ESS2-2), (2-ESS2-2), (2-ESS2-3)
- MP.4 Model with mathematics. (2-ESS1-1), (2-ESS2-1), (2-ESS2-2)
- MP.5 Use appropriate tools strategically. (2-ESS1-1)
- NY-2.NBT Understand place value. (2-ESS1-1)
- NY-2.NBT.3 Read and write numbers to 1000 using base-ten numerals, number names, and expanded form. (2-ESS2-2)
- NY-2.MD.5 Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., using drawings and equations with a symbol for the unknown number to represent the problem. (2-ESS2-1)

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

#### K-2. Engineering Design

Students who demonstrate understanding can:

**K-2-ETS1.1.** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

**K-2-ETS1.2.** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

**K-2-ETS1.3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

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<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking Questions and Defining Problems</td>
<td><strong>ETS1.A: Defining and Delimiting Engineering Problems</strong>&lt;br&gt; - A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1)&lt;br&gt; - Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)&lt;br&gt; - Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)&lt;br&gt; <strong>ETS1.B: Developing Possible Solutions</strong>&lt;br&gt; - Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2)&lt;br&gt; <strong>ETS1.C: Optimizing the Design Solution</strong>&lt;br&gt; - Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)</td>
<td><strong>Structure and Function</strong>&lt;br&gt; - The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)</td>
</tr>
<tr>
<td>Developing and Using Models</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.</td>
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<tr>
<td>- Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2)</td>
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</tr>
<tr>
<td>Analyzing and Interpreting Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations.</td>
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</tr>
<tr>
<td>- Analyze data from tests of an object or tool to determine if it works as intended. (K-2-ETS1-3)</td>
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</tr>
</tbody>
</table>

**Connections to K-2-ETS1.A: Defining and Delimiting Engineering Problems include:**

**Kindergarten:** K-PS2-2, K-ESS3-2

**Connections to K-2-ETS1.B: Developing Possible Solutions to Problems include:**

**Kindergarten:** K-ESS3-3. **First Grade:** 1-PS4-4. **Second Grade:** 2-LS2-2

**Connections to K-2-ETS1.C: Optimizing the Design Solution include:**

**Second Grade:** 2-ESS2-1

**Articulation of DCIs across grade-bands:** 3-5.ETS1.A (K-2-ETS1-1),(K-2-ETS1-2),(K-2-ETS1-3); 3-5.ETS1.B (K-2-ETS1-2),(K-2-ETS1-3); 3-5.ETS1.C (K-2-ETS1-1),(K-2-ETS1-2),(K-2-ETS1-3)

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

**E/LA/Literacy –**

2R1. Develop and answer to demonstrate understanding of key ideas and details in a text. (K-2-ETS1-1)

2W7. Recall and represent information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1),(K-2-ETS1-3)

2SL5. Include digital media and/or visual displays in presentations to clarify ideas, thoughts, and feelings. (K-2-ETS1-2)

**Mathematics –**

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

MP.4. Model with mathematics. (K-2-ETS1-1),(K-2-ETS1-3)

MP.5. Use appropriate tools strategically. (K-2-ETS1-1),(K-2-ETS1-3)

**NY-2.MD.10.** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-1),(K-2-ETS1-3)

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

3. Forces and Interactions

Students who demonstrate understanding can:

3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. [Clarification Statement: Examples could include an unbalanced force on one side of an object can make it start moving, and balanced forces (including friction) acting on a stationary object from both sides will not produce any motion at all.]
[Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.]

3-PS2-2. Make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion. [Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.] [Assessment Boundary: Assessment does not include technical terms such as period and frequency.]

3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. [Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.]

3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.* [Clarification Statement: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.]

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

Science and Engineering Practices

- Asking Questions and Defining Problems
  - Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.
  - Example questions that can be investigated based on patterns such as cause and effect relationships.
  - A simple problem that can be solved through the development of a new or improved object or tool.

- Planning and Carrying Out Investigations
  - Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigating that control variables and provide evidence to support explanations or design solutions.
  - Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence of change in force and motion.
  - Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or design a solution.

Disciplinary Core Ideas

PS2.A: Forces and Motion
- Each force acts on a particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object’s speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.)
- The patterns of an object’s motion in various situations can be observed and measured; when that motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.)

PS2.B: Types of Interactions
- Objects in contact exert forces on each other.
- Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart, and for forces between two magnets, on their orientation relative to each other.

Crosscutting Concepts

- Patterns
  - Patterns of change can be used to make predictions.

- Cause and Effect
  - Cause and effect relationships are routinely identified. (3-PS2-1)
  - Cause and effect relationships are routinely identified, tested, and used to explain change. (3-PS2-3)

Interdependence of Science, Engineering, and Technology

- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process.

Connections to Other Disciplinary Core Ideas

New Articulation of Discs across grade-levels:
- K.PS2.A: (3-PS2-1); K.PS3.B: (3-PS2-1); K.PS3.C: (3-PS2-1); K.ETS1.A: (3-PS2-4); 1.ESS1.A: (3-PS2-2); 4.ESS1.A: (3-PS2-2); 4.ESS1.A: (3-PS2-4); P.SB.2 (3-PS2-1); MS.PS2.A (3-PS2-1); MS.PS2.B (3-PS2-3); MS.PS2.C (3-PS2-1); MS.ESS1.B (3-PS2-1); MS.ESS2.A (3-PS2-1)

New York State Next Generation Learning Standards Connections:
- ELA/Literacy:
  - 3R1: Develop and answer questions to locate relevant and specific details in a text to support an answer or inference.
  - 3R3: In informational texts, describe the relationship among a series of events, ideas, concepts, or steps in a text, using language that pertains to time, sequence, and cause/effect.
  - 3R8: Explain how claims in a text are supported by relevant reasons and evidence.
  - 3W6: Conduct research to answer questions, including self-generated questions, and to build knowledge.
  - 3W7: Recall relevant information from qualitative experiences or gather information from multiple sources; take brief notes on sources and sort evidence into provided categories.

- Mathematics:
  - MP.2: Reason abstractly and quantitatively.
  - MP.5: Use appropriate tools strategically.
  - NY-3.MD.2: Measure and estimate liquid volumes and masses of objects using grammes (g), kilogrammes (kg), and litres (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units.

*Connection boxes updated as of September 2018

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

**Analyzing and Interpreting Data**
- Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.
  - Analyze and interpret data to make sense of phenomena using logical reasoning.

**Engaging in Argument from Evidence**
- Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed worlds.
  - Construct an argument with evidence, data, and/or a model.
  - Construct an argument with evidence.
  - Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.

### Disciplinary Core Ideas

**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**
- When the environment changes in ways that affect a place’s physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (secondary to 3-LS4-4)

**LS2.D: Social Interactions and Group Behavior**
- (NYSED) Being part of a group helps some animals obtain food, defend themselves, and survive. Groups may serve different functions and vary dramatically in size. (Note: Moved from K–2)

**LS4.A: Evidence of Common Ancestry and Diversity**
- Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (Note: Moved from K–2)
- Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1)

**LS4.C: Adaptation**
- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3)

**LS4.D: Biodiversity and Humans**
- Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (3-LS4-4)

### Crosscutting Concepts

**Cause and Effect**
- Cause and effect relationships are routinely identified and used to explain change. (3-LS2-1,3-LS4-3)

**Scale, Proportion, and Quantity**
- Observable phenomena exist from very short to very long time periods. (3-LS4-1)

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

**Interdependence of Science, Engineering, and Technology**
- Knowledge of relevant scientific concepts and research findings is important in engineering. (3-LS4-4)

### Connections to Nature of Science

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**
- Science assumes consistent patterns in natural systems. (3-LS4-1)

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

**ELA/Literacy**
- 3R1 Develop and answer questions to locate relevant and specific details in a text to support an answer or inference.
- 3R2 Determine a theme or central idea and explain how it is supported by key details; summarize portions of a text.
- 3R3 In informational texts, describe the relationship among a series of events, ideas, concepts, or steps in a text, using language that pertains to time, sequence, and cause/effect.
- 3W1 Write an argument to support claim(s), using clear reasons and relevant evidence.
- 3W7 Recall relevant information from experiences or gather information from multiple sources; take brief notes on sources and sort evidence into provided categories.
- 3SL4 Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.

**Mathematics**
- MP.2 Reason abstractly and quantitatively.
- MP.4 Use the tools strategically.
- MP.5 Use appropriate tools strategically.
- NY-3.NBT.2 Number and Operations in Base Ten
- NY-3.MD.4 Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs.
- NY-4.MD.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters.

*Connection boxes updated as of September 2018*
3. Inheritance and Variation of Traits: Life Cycles and Traits

<table>
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<tr>
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</thead>
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<tr>
<td><strong>Developing and Using Models</strong></td>
<td><strong>LS1.B: Growth and Development of Organisms</strong></td>
<td><strong>Patterns</strong></td>
</tr>
<tr>
<td>Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.</td>
<td>• Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)</td>
<td>• Similarities and differences in patterns can be used to sort and classify natural phenomena. (3-LS3-1)</td>
</tr>
<tr>
<td>• Develop models to describe phenomena. (3-LS1-1)</td>
<td><strong>LS3.A: Inheritance of Traits</strong></td>
<td><strong>Cause and Effect</strong></td>
</tr>
<tr>
<td>Analyzing and Interpreting Data</td>
<td>• Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)</td>
<td>• Cause and effect relationships are routinely identified and used to explain change. (3-LS3-2); (3-LS4-2)</td>
</tr>
<tr>
<td>Analyzing data in 3–5 builds on K-2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.</td>
<td>• Other characteristics result from individuals’ interactions with the environment, which can range from diet to learning. (3-LS3-2)</td>
<td></td>
</tr>
<tr>
<td>• Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS3-1)</td>
<td>• (NYSED) Some characteristics result from the interactions of both inheritance and the effect of the environment. (3-LS3-2)</td>
<td><strong>Connections</strong></td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td><strong>LS3.B: Variation of Traits</strong></td>
<td></td>
</tr>
<tr>
<td>Constructing explanations and designing solutions in 3–5 builds on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.</td>
<td>• Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1)</td>
<td></td>
</tr>
<tr>
<td>• Use evidence (e.g., observations, patterns) to support an explanation. (3-LS3-2)</td>
<td>• The environment also affects the traits that an organism develops. (3-LS3-2)</td>
<td></td>
</tr>
<tr>
<td>• Use evidence (e.g., observations, patterns) to construct an explanation. (3-LS4-2)</td>
<td><strong>LS4.B: Natural Selection</strong></td>
<td><strong>NY-3.MD.1</strong></td>
</tr>
<tr>
<td><strong>Connections to Nature of Science</strong></td>
<td>• Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. (3-LS4-2)</td>
<td><strong>NY-3.MD.2</strong></td>
</tr>
<tr>
<td>Scientific Knowledge is Based on Empirical Evidence</td>
<td><strong>NY-3.MD.3</strong></td>
<td><strong>NY-3.MD.4</strong></td>
</tr>
<tr>
<td>• Science findings are based on recognizing patterns. (3-LS1-1)</td>
<td><strong>NY-3.NBT</strong></td>
<td><strong>NY-3.NF</strong></td>
</tr>
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**New York State Next Generation Learning Standards Connections:**

<table>
<thead>
<tr>
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<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3R1</strong></td>
<td><strong>NY-3.MD.1</strong></td>
</tr>
<tr>
<td>Develop and answer questions to locate relevant and specific details in a text to support an answer or inference. (3-LS1-1); (3-LS3-1); (3-LS4-2)</td>
<td><strong>NY-3.MD.2</strong></td>
</tr>
<tr>
<td><strong>3R2</strong></td>
<td><strong>NY-3.NBT</strong></td>
</tr>
<tr>
<td>Determine a theme or central idea and explain how it is supported by key details; summarize portions of a text. (3-LS1-1); (3-LS3-1); (3-LS4-2)</td>
<td><strong>NY-3.NF</strong></td>
</tr>
<tr>
<td><strong>3R3</strong></td>
<td><strong>NY-3.MD.3</strong></td>
</tr>
<tr>
<td>In informational texts, describe the relationship among a series of events, ideas, concepts, or steps in a text, using language that pertains to time, sequence, and cause/effect. (3-LS1-1); (3-LS3-1); (3-LS4-2)</td>
<td><strong>NY-3.MD.4</strong></td>
</tr>
<tr>
<td><strong>3R7</strong></td>
<td><strong>NY-3.MD.5</strong></td>
</tr>
<tr>
<td>Explain how specific illustrations or text features contribute to what is conveyed by the words in a text (e.g., create mood, emphasize character or setting, or determine where, when, why, and how key events occur). (3-LS1-1)</td>
<td><strong>NY-3.MD.6</strong></td>
</tr>
<tr>
<td><strong>3W2</strong></td>
<td><strong>NY-3.MD.7</strong></td>
</tr>
<tr>
<td>Write informative/explanatory texts to explore a topic and convey ideas and information relevant to the subject. (3-LS1-1); (3-LS3-1); (3-LS4-2)</td>
<td><strong>NY-3.MD.8</strong></td>
</tr>
<tr>
<td><strong>3SL4</strong></td>
<td><strong>NY-3.MD.9</strong></td>
</tr>
<tr>
<td>Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. (3-LS1-1); (3-LS3-1); (3-LS4-2)</td>
<td><strong>NY-3.MD.10</strong></td>
</tr>
<tr>
<td><strong>3SL5</strong></td>
<td><strong>NY-3.MD.11</strong></td>
</tr>
<tr>
<td>Include digital media and/or visual displays in presentations to emphasize certain facts or details. (3-LS1-1)</td>
<td><strong>NY-3.MD.12</strong></td>
</tr>
</tbody>
</table>

**NY-3.NBT**

- Understand place value.
- Identify place value patterns in numeric patterns.
- Use place value understanding to compare two-digit numbers.
- Compare numbers in different forms.

**NY-3.NF**

- Understand fractions as numbers.
- Value fractions in different forms.
- Create fractions in different forms.

**NY-3.MD.1**

- Measure and estimate lengths in standard units.
- Solve problems involving addition and subtraction of lengths in standard units.
- Represent lengths on a number line diagram.

**NY-3.MD.2**

- Relate area to units and square units.
- Relate area to multiplication and addition.
- Solve problems involving area and perimeter.

**NY-3.MD.3**

- Tell and write time to the nearest five minutes.
- Solve word problems involving time, money, and measurement of intervals of time.

**NY-3.MD.4**

- Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.
- Show data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters.

**NY-3.MD.5**

- Understand the concept of area and its measurement units.
- Relate area to the operations of multiplication and addition.

**NY-3.MD.6**

- Relate area to the operations of multiplication and addition.
- Understand the concept of area and its measurement units.

**NY-3.MD.7**

- Relate area to the operations of multiplication and addition.
- Understand the concept of area and its measurement units.

**NY-3.MD.8**

- Relate area to the operations of multiplication and addition.
- Understand the concept of area and its measurement units.

**NY-3.MD.9**

- Relate area to the operations of multiplication and addition.
- Understand the concept of area and its measurement units.

**NY-3.MD.10**

- Relate area to the operations of multiplication and addition.
- Understand the concept of area and its measurement units.

**NY-3.MD.11**

- Relate area to the operations of multiplication and addition.
- Understand the concept of area and its measurement units.

**NY-3.MD.12**

- Relate area to the operations of multiplication and addition.
- Understand the concept of area and its measurement units.
### Science and Engineering Practices

#### Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-ESS2-3)
- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation or test a design solution. (3-ESS2-3)

#### Analyzing and Interpreting Data

Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.

- Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships. (3-ESS2-1)

#### Engaging in Argument from Evidence

Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).

- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-ESS3-1)

#### Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.

- Obtain and combine information from books and other reliable media to explain phenomena. (3-ESS2-2)

#### Disciplinary Core Ideas

**ESS2.D: Weather and Climate**

- Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)
- Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (3-ESS2-2)
- (NYSED) Earth's processes continuously cycle water, contributing to weather and climate. (3-ESS2-3)

**ESS3.B: Natural Hazards**

- A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1) (Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2)

### Crosscutting Concepts

**Patterns**

- Patterns of change can be used to make predictions. (3-ESS2-2)

**Cause and Effect**

- Cause and effect relationships are routinely identified, tested, and used to explain change. (3-ESS3-2), (3-ESS3-1)

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

**Science is a Human Endeavor**

- Science affects everyday life. (3-ESS3-1)

### Articulation of DCIs across grade-levels:

**K.ESS2.D:** (3-ESS2-1); **K.ESS3.B:** (3-ESS3-1); **K.ETS1.A:** (3-ESS3-1); **4.ESS2.A:** (3-ESS2-1); **4.ESS3.B:** (3-ESS3-1); **4.ESS1.A:** (3-ESS3-1)

**5.ESS2.A:** (3-ESS2-1); **MS.ESS2.A:** (3-ESS2-1); **(3-ESS2-2); MS.ESS2.D:** (3-ESS2-1), (3-ESS2-2); **MS.ESS3.B:** (3-ESS3-1)

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

**EAL/Literacy -**

- **3R1:** Develop and answer questions to locate relevant and specific details in a text to support an answer or inference. (3-ESS2-2)
- **3W1:** Write opinion pieces on topics or texts, supporting a point of view with reasons. (3-ESS3-1)
- **3W6:** Conduct research to answer questions, including self-generated questions, and to build knowledge about a topic. (3-ESS3-3)
- **3W7:** Recall relevant information from experiences or gather information from multiple sources; take brief notes on sources and sort evidence into provided categories. (3-ESS2-2)

**Mathematics -**

- **MP.2:** Reason abstractly and quantitatively. (3-ESS2-1), (3-ESS2-2), (3-ESS3-1)
- **MP.4:** Model with mathematics. (3-ESS2-1), (3-ESS2-2), (3-ESS3-1)
- **MP.5:** Use appropriate tools strategically. (3-ESS2-1), (3-ESS2-2), (3-ESS3-1)
- **NY-3.MD.2:** Measure and estimate liquid volumes and masses of objects using grams (g), kilograms (kg), and liters (L). Add, subtract, multiply, or divide to solve one-step word problems involving masses or liquid volumes that are given in the same units. (3-ESS2-1), (3-ESS3-2)
- **NY-3.MD.3:** Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step “how many more” and “how many less” problems using information presented in scaled picture graph or scaled bar graphs. (3-ESS2-1)

*Connection boxes updated as of September 2018*

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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The text in the “Disciplinary Core Ideas” section is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas unless it is preceded by (NYSED).*
4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.

Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.

4-PS3-2. Make observations to provide evidence that energy is conserved as it is transferred and/or converted from one form to another. [Clarification Statement: Examples of forms of energy could include sound, light, heat, and electrical.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. [Clarification Statement: Examples of renewable energy resources could include wind, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]

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

<table>
<thead>
<tr>
<th>Asking Questions and Defining Problems</th>
<th>Disciplinary Core Ideas</th>
<th>Disciplinary Core Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking questions and defining problems in grades 3–5 builds on grades K-2 experiences and progresses to specifying qualitative relationships.</td>
<td>PS3.A: Definitions of Energy</td>
<td>Core Ideas</td>
</tr>
<tr>
<td>• Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3)</td>
<td>(NYSED) A given object possesses more energy of motion when it moves faster.</td>
<td><strong>Cause and Effect</strong></td>
</tr>
<tr>
<td>Planning and Carrying Out Investigations</td>
<td>Planning and Carrying Out Investigations</td>
<td>• Cause and effect relationships are routinely identified and used to explain change. (4-ESS3-3)</td>
</tr>
<tr>
<td>Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.</td>
<td></td>
<td>Energy and Matter</td>
</tr>
<tr>
<td>• Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-3)</td>
<td>(NYSED) Energy can be transferred by moving objects or by sound, light, heat, or electric currents. (4-PS3-2), (4-PS3-3)</td>
<td>• Energy can be transferred in various ways and between objects. (4-ESS3-3). (4-PS3-3), (4-PS3-4)</td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>Constructing Explanations and Designing Solutions</td>
<td><strong>Crosscutting Concepts</strong></td>
</tr>
<tr>
<td>Constructing explanations and designing solutions in 3–5 builds on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to solving problems. (4-PS3-4)</td>
<td>PS3.B: Conservation of Energy and Energy Transfer</td>
<td>Interdependence of Science, Engineering, and Technology</td>
</tr>
<tr>
<td>• Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-3)</td>
<td>• Knowledge of relevant scientific concepts and research findings is important in engineering. (4-ESS3-1)</td>
<td><strong>Applications of Science</strong></td>
</tr>
<tr>
<td>• Apply scientific ideas to solve design problems. (4-PS3-4)</td>
<td>(NYSED) Energy can also be transferred by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2), (4-PS3-4)</td>
<td>Interdependence of Science, Engineering, and Technology</td>
</tr>
<tr>
<td>Obtaining, Evaluating, and Communicating Information</td>
<td>PS3.C: Relationship Between Energy and Forces</td>
<td>Science affects everyday life. (4-PS3-4)</td>
</tr>
<tr>
<td>Obtaining, evaluating, and communicating information in 3–5 builds on K-2 experiences and progresses to evaluate the merit and accuracy of ideas and methods.</td>
<td>When objects collide, the contact forces transfer energy so as to change the objects’ motions. (4-PS3-3)</td>
<td>• Over time, people’s needs and wants change, as do their demands for new and improved technologies. (4-ESS3-1)</td>
</tr>
<tr>
<td>• Obtain and combine information from books and other reliable media to explain phenomena. (4-ESS3-1)</td>
<td>PS3.D: Energy in Chemical Processes and Everyday Life</td>
<td>• Engineers improve existing technologies or develop new ones. (4-PS3-4)</td>
</tr>
<tr>
<td></td>
<td>• The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4)</td>
<td><strong>Connections to Nature of Science</strong></td>
</tr>
<tr>
<td></td>
<td>ES53.A: Natural Resources</td>
<td>Science is a Human Endeavor</td>
</tr>
<tr>
<td></td>
<td>• Energy and fuels that humans use are derived from natural sources, and their availability changes over time. Some sources are renewable over time, and others are not. (4-ESS3-1)</td>
<td>• Most scientists and engineers work in teams. (4-PS3-4)</td>
</tr>
<tr>
<td></td>
<td>ETS1.A: Defining Engineering Problems</td>
<td>• Science affects everyday life. (4-PS3-4)</td>
</tr>
<tr>
<td></td>
<td>• Possible solutions to a problem are limited by available materials and resources. (4-PS3-4)</td>
<td></td>
</tr>
<tr>
<td><strong>NY-4.OA.3</strong></td>
<td>Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. (4-PS3-4)</td>
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<td>---------------</td>
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</tbody>
</table>

*Connection boxes updated as of September 2018*

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### 4. Waves: Waves and Information

Students who demonstrate understanding can:

**4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.** [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.]

**4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.* [Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.]

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### Science and Engineering Practices

**Developing and Using Models**
- Modeling in 3–5 builds on K–2 experiences and progresses to represent events and design solutions.
  - Develop a model using an analogy, example, or abstract representation to describe a scientific principle. (4-PS4-1)

**Constructing Explanations and Designing Solutions**
- Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.
  - Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-PS4-3)

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### Disciplinary Core Ideas

**PS4.A: Wave Properties**
- Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. (Note: This grade-band endpoint was moved from K–2). (4-PS4-1)
- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1)

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### Crosscutting Concepts

**Patterns**
- Similarities and differences in patterns can be used to sort and classify natural (4-PS4-1)
- Similarities and differences in patterns can also be used to sort and classify designed products. (4-PS4-3)

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### Connections to Nature of Science

**Scientific Knowledge is Based on Empirical Evidence**
- Science findings are based on recognizing patterns. (4-PS4-1)

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

**ELA/Literacy**
- **4.R1** Locate and refer to relevant details and evidence when explaining what a text says explicitly/implicitly and make logical inferences. (4-PS3-1)
- **4.SL5** Include digital media and/or visual displays in presentations to emphasize central ideas or themes. (4-PS4-1)

**Mathematics**
- **MP.4** Model with mathematics. (4-PS4-1)
- **NY-4.G.1** Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. (4-PS4-1)

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*Connection boxes updated as of September 2018*
### 4. Structure, Function, and Information Processing

Students who demonstrate understanding can:

**4-PS4-2.** Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. [Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.]

**4-LS1-1.** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.] [Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.]

**4-LS1-2.** Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. [Clarification Statement: Emphasis is on systems of information transfer.] [Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.]

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

#### Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>PS4.B: Electromagnetic Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LS1.A: Structure and Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LS1.D: Information Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)</td>
</tr>
</tbody>
</table>

#### Science and Engineering Practices

<table>
<thead>
<tr>
<th>Developing and Using Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing a model to describe phenomena. (4-PS4-2)</td>
</tr>
<tr>
<td>Using a model to test interactions concerning the functioning of a natural system. (4-LS1-2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engaging in Argument from Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engaging in argument from evidence in 3-5 builds on K-2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).</td>
</tr>
<tr>
<td>Construct an argument with evidence, data, and/or a model. (4-LS1-1)</td>
</tr>
</tbody>
</table>

#### Crosscutting Concepts

<table>
<thead>
<tr>
<th>Cause and Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Cause and effect relationships are routinely identified. (4-PS4-2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Systems and System Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>- A system can be described in terms of its components and their interactions. (4-LS1-1), (LS1-2)</td>
</tr>
</tbody>
</table>

*Connections to other DCIs in fourth grade: N/A*

**Articulation of DCIs across grade-levels:**

1. PS4.B (4-PS4-2); 1.LS1.A (4-LS1-1); 1.LS1.D (4-LS1-2); 1.LS3.B (4-LS1-1); MS.PS4.B (4-PS4-2); MS.LS1.A (4-LS1-1), (4-LS1-2); MS.LS1.D (4-PS4-2), (4-LS1-2)

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

**ELA/Literacy** -

- **4W1** Write an argument to support claim(s), using clear reasons and relevant evidence. (4-LS1-1)
- **4SL5** Include digital media and/or visual displays in presentations to emphasize central ideas or themes. (4-PS4-2),(4-LS1-2)

**Mathematics** -

- **MP.4** Model with mathematics. (4-PS4-2)
- **NY-4.G.1** Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. (4-LS1-1)
- **NY-4.G.3** Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry. (4-PS3-4)

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

#### 4. Earth's Systems: Processes that Shape the Earth

Students who demonstrate understanding can:

**4-ESS1-1.** Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.  
- **Clarification Statement:** Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; tilted rock layers indicate past crustal movement; glacial scratches on rock formations indicating glacier movement; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock. [Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.]

**4-ESS1-2.** Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.  
- **Clarification Statement:** Examples of variables to test could include angle of slope in the downhill movement of water and/or loose Earth materials due to gravity, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow. [Assessment Boundary: Assessment is limited to a single form of weathering or erosion.]  

**4-ESS2-2.** Analyze and interpret data from maps to describe patterns of Earth’s features.  
- **Clarification Statement:** Maps can include topographic maps of Earth’s land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.  

**4-ESS3-2.** Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*  
- **Clarification Statement:** Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.

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<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planning and Carrying Out Investigations</strong></td>
<td><strong>ESS1.C: The History of Planet Earth</strong></td>
<td><strong>Patterns</strong></td>
</tr>
<tr>
<td>- Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations.</td>
<td>- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)</td>
<td>- Patterns can be used as evidence to support an explanation. (4-ESS1-1), (4-ESS2-2)</td>
</tr>
<tr>
<td>- Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (4-ESS2-1)</td>
<td><strong>ESS2.A: Earth Materials and Systems</strong></td>
<td><strong>Cause and Effect</strong></td>
</tr>
<tr>
<td>- Analyze and interpret data to make sense of phenomena using logical reasoning. (4-ESS2-2)</td>
<td>- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1)</td>
<td>- Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS2-1), (4-ESS2-2)</td>
</tr>
<tr>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td><strong>ESS2.B: Plate Tectonics and Large-Scale System Interactions</strong></td>
<td><strong>Connections to Engineering, Technology, and Applications of Science</strong></td>
</tr>
<tr>
<td>- Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.</td>
<td>- The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2)</td>
<td>- Influence of Engineering, Technology, and Science on the Natural World</td>
</tr>
<tr>
<td>- Identify the evidence that supports particular points in an explanation. (4-ESS1-1)</td>
<td><strong>ESS2.E: Biogeology</strong></td>
<td>- Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands. (4-ESS3-2)</td>
</tr>
<tr>
<td>- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-ESS2-3)</td>
<td>- Living things affect the physical characteristics of their regions. (4-ESS2-2)</td>
<td><strong>Connections to Nature of Science</strong></td>
</tr>
<tr>
<td><strong>ETS1.B: Designing Solutions to Engineering Problems</strong></td>
<td><strong>ESS3.B: Natural Hazards</strong></td>
<td><strong>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</strong></td>
</tr>
<tr>
<td>- Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS2-2)</td>
<td>- A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) (Note: This Disciplinary Core Idea can also be found in 3.WC.)</td>
<td>- Science assumes consistent patterns in natural systems. (4-ESS1-1)</td>
</tr>
</tbody>
</table>

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*Connections to other DCIs in fourth grade: 4.ESS1.C (4-ESS3-2)


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

**ELA/Literacy -**

**4R1** Locate and refer to relevant details and evidence when explaining what a text says explicitly/implicitly and make logical inferences. (4-ESS3-2)

**4R7** Identify information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, illustrations, and explain how the information contributes to an understanding of the text). (4-ESS2-2)

**4W6** Conduct research to answer questions, including self-generated questions, and to build knowledge through investigating multiple aspects of a topic. (4-ESS1-1), (4-ESS2-1)

**4W7** Recall relevant information from experiences or gather relevant information from multiple sources: take notes and categorize information and provide a list of sources. (4-ESS1-1), (4-ESS2-1)

**4W5** Draw evidence from literary or informational texts to respond and support analysis, reflection, and research by applying grade 4 reading standards. (4-ESS1-1)

**Mathematics -**

**MP.2** Reason abstractly and quantitatively. (4-ESS1-1), (4-ESS2-1), (4-ESS2-2)

**MP.4** Model with mathematics. (4-ESS1-1), (4-ESS2-1), (4-ESS2-2)

**MP.5** Use appropriate tools strategically. (4-ESS2-1)

**NY-4.MD.1** Know relative sizes of measurement units: ft., in.; km, m, cm. Know the conversion factor and use it to convert measurements in a larger unit in terms of a smaller unit: ft.; in.; km, m, cm; hr., min., sec. Given the conversion factor, convert all other measurements within a single system of measurement from a larger unit to a smaller unit. Record measurement equivalents in a two-column table. (4-ESS1-1), (4-ESS2-1)

**NY-4.MD.2** Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money. Solve problems involving fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams that feature a measurement scale, such as number line diagrams. (4-ESS1-1), (4-ESS2-1), (4-ESS2-2)

**NY-4.OA.1** Interpret a multiplication equation as a comparison. Represent verbal statements of multiplicative comparisons as multiplication equations. (4-ESS2-2)

*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).*
5. Structure and Properties of Matter

Students who demonstrate understanding can:

5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]

5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances the total amount of matter is conserved. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing substances that form new substances. Assume that reactions with any gas production are conducted in a closed system.] [Assessment Boundary: Assessment does not include distinguishing between mass and weight.]

5-PS1-3. Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility. Density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing between mass and weight.]

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances. [Clarification Statement: Examples could include mixing baking soda and water compared to mixing baking soda and vinegar.]

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

<table>
<thead>
<tr>
<th>Developing and Using Models</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
</table>
| Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ~ Develop a model to describe phenomena. (5-PS1-1) | PS1.A: Structure and Properties of Matter
- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) | Cause and Effect
- Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) |
| Planning and Carrying Out Investigations | PS1.B: Chemical Reactions
- When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4) | Scale, Proportion, and Quantity
- Natural objects exist from the very small to the immensely large. (5-PS1-1) |
| Mathematical and computational thinking | No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) (5-PS1-2) | Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-2), (5-PS1-3) |
| Mathematical and computational thinking | Measure and graph quantities such as weight to address scientific and engineering questions and phenomena. (5-PS1-2) | Connections to Nature of Science
- Science assumes consistent patterns in natural systems. (5-PS1-2) |
| Mathematical and computational thinking | Measure and graph quantities such as weight to address scientific and engineering questions and phenomena. (5-PS1-2) | |
| Mathematical and computational thinking | Measure and graph quantities such as weight to address scientific and engineering questions and phenomena. (5-PS1-2) | |

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade levels: 2.PS1.A (5-PS1-1),(5-PS1-2),(5-PS1-3); 2.PS1.B (5-PS1-2),(5-PS1-4); MS.PS1.A (5-PS1-1),(5-PS1-2),(5-PS1-3),(5-PS1-4); 5-PS1.B (5-PS1-2),(5-PS1-4)

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

SW6 Conduct research to answer questions, including self-generated questions, and to build knowledge through investigation of multiple aspects of a topic using multiple sources. (5-PS1-2),(5-PS1-3),(5-PS1-4)

SW7 Recall relevant information from experiences or gather relevant information from multiple sources; summarize or paraphrase; avoid plagiarism and provide a list of sources. (5-PS1-2),(5-PS1-3),(5-PS1-4)

SW5 Draw evidence from literary or informational texts to respond and support analysis, reflection, and research by applying the Grade 5 Reading Standards. (5-PS1-2),(5-PS1-3),(5-PS1-4)

Mathematics:

MP.2 Reason abstractly and quantitatively. (5-PS1-1),(5-PS1-2),(5-PS1-3)

MP.4 Model with mathematics. (5-PS1-1),(5-PS1-2),(5-PS1-3)

MP.5 Use appropriate tools strategically. (5-PS1-2),(5-PS1-3)

NY-5.NBT.1 Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left. (5-PS1-1)

NY-5.NF.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions. (5-PS1-1)

NY-5.MD.1 Convert among different-sized standard measurement units within a given measurement system when the conversion factor is given. Use these conversions in solving multi-step, real-world problems. (5-PS1-2)

NY-5.MD.3 Recognize volume as an attribute of solid figures and understand concepts of volume measurement. (5-PS1-1)

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

### 5. Matter and Energy in Organisms and Ecosystems

**Science and Engineering Practices**

<table>
<thead>
<tr>
<th>Developing and Using Models</th>
<th>Engaging in Argument from Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling in 3-5 builds on K-2 experiences and progresses to revising and simplifying models and using models to represent events and design solutions.</td>
<td>Engaging in argument from evidence in 3-5 builds on K-2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).</td>
</tr>
<tr>
<td>Use models to describe phenomena. (5-PS3-1)</td>
<td>Support an argument with evidence, data, or a model. (5-LS1-1)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Connections to Nature of Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science explanations describe the mechanisms for natural events. (5-LS2-1)</td>
</tr>
</tbody>
</table>

**Disciplinary Core Ideas**

<table>
<thead>
<tr>
<th>PS3.D: Energy in Chemical Processes and Everyday Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)</td>
</tr>
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</table>

<table>
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<tbody>
<tr>
<td>• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. (secondary to 5-PS3-1)</td>
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</table>

<table>
<thead>
<tr>
<th>LS2.A: Interdependent Relationships in Ecosystems</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants’ parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS1-1)</td>
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</table>

<table>
<thead>
<tr>
<th>LS2.B: Cycles of Matter and Energy Transfer in Ecosystems</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)</td>
</tr>
</tbody>
</table>

**Crosscutting Concepts**

<table>
<thead>
<tr>
<th>Systems and System Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A system can be described in terms of its components and their interactions. (5-LS2-1)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy and Matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Matter is transported into, out of, and within systems. (5-LS1-1)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>New York State Next Generation Learning Standards Connections:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ELA/Literacy</strong> -</td>
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<tr>
<td>5R1</td>
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<td>5R7</td>
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<td>5W1</td>
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<td>5SL5</td>
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<table>
<thead>
<tr>
<th><strong>Mathematics</strong> -</th>
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<tbody>
<tr>
<td>MP.2</td>
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<tr>
<td>MP.4</td>
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<tr>
<td>MP.5</td>
</tr>
</tbody>
</table>

| NY-5.MD.1 | Convert among different-sized standard measurement units within a given measurement system when the conversion factor is given. Use these conversions in solving multi-step, real world problems. (5-LS1-1) |

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### 5. Earth’s Systems

Students who demonstrate understanding can:

**5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.** [Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [Assessment Boundary: Assessment is limited to the interactions of two systems at a time.]

**5-ESS2-2. Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.** [Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.]

**5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect Earth’s resources and environment.** [Clarification Statement: Emphasis should be on how communities use information to sustain resources and the environment locally, regionally, nationally, and/or internationally.]

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 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.
  - Develop a model using an example to describe a scientific principle. (5-ESS2-1)

**Using Mathematics and Computational Thinking**
- Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.
  - Describe and graph quantities such as area and volume to address scientific questions. (5-ESS2-2)

**Obtaining, Evaluating, and Communicating Information**
- Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.
  - Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. (5-ESS3-1)

#### Disciplinary Core Ideas

**ESS2.A: Earth Materials and Systems**
- Earth’s major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth’s surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)

**ESS2.C: The Roles of Water in Earth’s Surface Processes**
- Nearly all of Earth’s available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)

**ESS3.C: Human Impacts on Earth Systems**
- Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth’s resources and environments. (5-ESS3-1)

#### Crosscutting Concepts

**Scale, Proportion, and Quantity**
- Standard units are used to measure and describe physical quantities such as weight, and volume. (5-ESS2-2)

**Systems and System Models**
- A system can be described in terms of its components and their interactions. (5-ESS2-1), (5-ESS3-1)

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## Connections to Other Disciplinary Ideas in Fifth Grade

**MS.ESS2.A** (5-ESS2-1); **2.ESS2.A** (5-ESS2-1); **3.ESS2.A** (5-ESS2-1); **4.ESS2.A** (5-ESS2-1); **5.ESS2.A** (5-ESS2-1); **5.ESS2.C** (5-ESS2-1), (5-ESS2-2); **MS.ESS2.D** (5-ESS2-1); **5.ESS3.A** (5-ESS2-1), (5-ESS3-1); **5.ESS3.C** (5-ESS3-1); **MS.ESS3.D** (5-ESS3-1)

## New York State Next Generation Learning Standards

**Connections: ELA/Literacy**
- **SR1** Locate and refer to relevant details and evidence when explaining what a text says explicitly/implicitly and make logical inferences. (5-ESS3-1)
- **SR7** Analyze how visual and multimedia elements contribute to meaning of literary and informational texts. (5-ESS2-1), (5-ESS2-2), (5-ESS3-1)
- **SW7** Recall relevant information from experiences or gather relevant information from multiple sources; summarize or paraphrase; avoid plagiarism and provide a list of sources. (5-ESS2-2), (5-ESS3-1)

**SSSL5** Include digital media and/or visual displays in presentations to emphasize and enhance central ideas or themes. (5-ESS2-1), (5-ESS2-2)

**Mathematics**
- **MP.2** Reason abstractly and quantitatively. (5-ESS2-1), (5-ESS2-2), (5-ESS3-1)
- **MP.4** Model with mathematics. (5-ESS2-1), (5-ESS2-2), (5-ESS3-1)
- **NY-5.G.2** Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. (5-ESS2-1)

*Connection boxes updated as of September 2018*

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### Science and Engineering Practices

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<thead>
<tr>
<th>Analyzing and Interpreting Data</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
</table>
| Analyzing data in 3-5 builds on K-2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.  
- Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.  
- Support an argument with evidence, data, or a model. (5-PS2-1), (5-ESS1-1) | PS2.B: Types of Interactions  
- The gravitational force of Earth acting on an object near Earth’s surface pulls that object toward the planet’s center. (5-PS2-1)  
ESS1.A: The Universe and its Stars  
- The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1)  
ESS1.B: Earth and the Solar System  
- The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2) | Patterns  
- Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena. (5-ESS1-2)  
Cause and Effect  
- Cause and effect relationships are routinely identified and used to explain change. (5-PS2-1)  
Scale, Proportion, and Quantity  
- Natural objects exist from the very small to the immensely large. (5-ESS1-1) |

### 5. Space Systems: Stars and the Solar System

**Students who demonstrate understanding can:**

**5-PS2-1.** Support an argument that the gravitational force exerted by Earth on objects is directed down.  
[Clarification Statement: “Down” is a local description of the direction that points toward the center of the spherical Earth.] [Assessment Boundary: Assessment does not include mathematical representation of gravitational force.]

**5-ESS1-1.** Support an argument that differences in the apparent brightness of the Sun compared to other stars is due to their relative distances from Earth.  
[Assessment Boundary: Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).]

**5-ESS1-2.** Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.  
[Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the Sun, moon, and some stars that are visible only in particular months.] [Assessment Boundary: Assessment does not include causes of seasons.]

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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## New York State P-12 Science Learning Standards

### 3-5. Engineering Design

Students who demonstrate understanding can:

3-5-ETS1-1. **Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.**

3-5-ETS1-2. **Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.**

3-5-ETS1-3. **Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.**

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.*

### Science and Engineering Practices

**Asking Questions and Defining Problems**
- Asking questions and defining problems in 3-5 builds on K-2 experiences and progresses to specifying qualitative relationships.
  - Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)

**Planning and Carrying Out Investigations**
- Planning and carrying out investigations to answer questions or test solutions to problems in 3-5 builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
  - Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3)

**Constructing Explanations and Designing Solutions**
- Constructing explanations and designing solutions in 3-5 builds on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.
  - Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)

### Disciplinary Core Ideas

**ETS1.A: Defining and Delimiting Engineering Problems**
- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)

**ETS1.B: Developing Possible Solutions**
- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
  - At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
  - Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)

**ETS1.C: Optimizing the Design Solution**
- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)

### Crosscutting Concepts

**Influence of Science, Engineering, and Technology on Society and the Natural World**
- People’s needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1)
- Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

**New York State Next Generation Learning Standards Connections: ELA/Literacy**
- SR1 Locate and refer to relevant details and evidence when explaining what a text says explicitly/implicitly and make logical inferences. (3-5-ETS1-2)
- SR7 Analyze how visual and multimedia elements contribute to meaning of literary and informational texts. (3-5-ETS1-2)
- SW5 Draw evidence from literary or informational texts to respond and support analysis, reflection, and research by applying the Grade 5 Reading Standards. (3-5-ETS1-2)
- SW6 Conduct research to answer questions, including self-generated questions, and to build knowledge through investigation of multiple aspects of a topic using multiple sources. (3-5-ETS1-2)
- SW8 Recall relevant information from experiences or gather relevant information from multiple sources; summarize or paraphrase; avoid plagiarism and provide a list of sources. (3-5-ETS1-2)

**Mathematics**
- MP.2 Reason abstractly and quantitatively. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
- MP.4 Model with Mathematics. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
- MP.5 Use tools strategically. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
- 3-5.OA Operations and Algebraic Thinking (3-5-ETS1-1),(3-5-ETS1-2)

*Connection boxes updated as of September 2018

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### Science and Engineering Practices

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

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

#### PS1.B: Chemical Reactions

- **(NYSED) Substances react chemically in characteristic ways.** In a chemical process, the atoms that make up the original substances are regrouped into different particles, and these new substances have different properties from those of the reactants. (MS-PS1-3) (Note: This Disciplinary Core Idea is also addressed by MS-LS1-2 and MS-PS1-5.)

#### PS3.A: Definitions of Energy

- **(NYSED) The term “heat” as used in everyday language refers both to thermal energy (the motion of particles within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.** (secondary to MS-PS1-4)
- **(NYSED) Temperature is not a form of energy.** Temperature is a measurement of the average kinetic energy of the particles in a sample of matter. (secondary to MS-PS1-4)

### Crosscutting Concepts

#### Patterns

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

#### Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural and 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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### New York State Next Generation Learning Standards Connections:

**ELA/Literacy –**

**6-8RST1**  
Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-PS1-3)

**6-8RST7**  
Identify and match scientific or technical information presented as text with a version of that information presented visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS1-1),(MS-PS1-4)

**6-8WHST.8**  
Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source by applying discipline specific criteria used in the social sciences or sciences; and quote or paraphrase the data/accounts and conclusions of others while avoiding plagiarism and following a standard format for citation or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-PS1-3), (MS-PS1-7)

**Mathematics –**

**MP.2**  
Reason abstractly and quantitatively. (MS-PS1-1), (MS-PS1-8)

**MP.4**  
Model with mathematics. (MS-PS1-1)

**NY-6.RP.4**  
Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-1),(MS-PS1-7)

**NY-6.NS.5**  
Understand that positive and negative numbers are used together to describe quantities having opposite directions or values. Use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-PS1-4)

**NY-8.EE.3**  
Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. (MS-PS1-1)

*Connection boxes updated as of September 2018*

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### 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 Statement: Assessment is limited to an 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 Statement: 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.**

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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</thead>
<tbody>
<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.</td>
<td>• Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)</td>
</tr>
<tr>
<td>Analyzing and Interpreting Data</td>
<td>PS1.B: Chemical Reactions</td>
<td>Energy and Matter</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>(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.</td>
<td>• Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5)</td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>PS1.C: Matter and Its Changes</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>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>PS1.8: Developing Possible Solutions</td>
<td></td>
</tr>
<tr>
<td>• Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.</td>
<td>• A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.</td>
<td></td>
</tr>
<tr>
<td>(MS-PS1-6)</td>
<td>(secondary to MS-PS1-6)</td>
<td>(secondary to MS-PS1-6)</td>
</tr>
</tbody>
</table>

**Connections to Nature of Science**

**Scientific Knowledge is Based on Empirical Evidence**

- 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)

**Crosscutting Concepts**

Patterns

- Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)

Energy and Matter

- The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)

Articulation of DOK across grade-bands: 5-PS1.B (MS-PS1-2),(MS-PS1-5); HS-PS1.A (MS-PS1-6); HS-PS3.A (MS-PS1-6)

**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)

- 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-PS1-1)

- 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)

- 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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### 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 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. |

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### 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.
- Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (MS-PS2-3)

#### 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-PS2-2)
- Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. (MS-PS2-5)

#### Constructing Explanations and Designing Solutions
- Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
- Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1)

#### Engaging in Argument from Evidence
- Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.
- Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-PS2-4)

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### Disciplinary Core Ideas

#### 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).
- 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 achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)

#### 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, but 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)

### Crosscutting Concepts

#### Cause and Effect
- Cause and effect relationships may be evident in phenomena in natural or designed systems. (MS-PS2-3), (MS-PS2-5)

#### Systems and System Models
- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-1), (MS-PS2-4)

#### Stability and Change
- Explaining of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)

### Connections to Nature of Science

#### 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. (MS-PS2-1)

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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-PS-2-1),(MS-PS2-3)

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

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

Mathematics -

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

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

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

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

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

*Connection boxes updated as of September 2018

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Students who demonstrate understanding can:

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

**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 car 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 electrostatics of charged objects.]

**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 transfer.]

**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 transfer.]

**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.
to support or refute an explanation or a model for a phenomenon. (MS-PS3-5)

**Connections to Nature of Science**

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

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

- **4.PS3.B** (MS-PS3-1), (MS-PS3-3), (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)

**Articulation of DCIs across grade-bands:**

- **4.PS3.B** (MS-PS3-1), (MS-PS3-3), (MS-PS3-4), (MS-PS3-5), **HS.PS3.B** (MS-PS3-1), (MS-PS3-2), (MS-PS3-3), (MS-PS3-4), (MS-PS3-5), **HS.PS3.C** (MS-PS3-2)

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### 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 the specific mechanism of any given device.]

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<td><strong>Developing and Using Models</strong></td>
<td><strong>PS4.A: Wave Properties</strong></td>
<td></td>
</tr>
<tr>
<td>Modeling in 6-8 builds on K-5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)</td>
<td><strong>Patterns</strong></td>
</tr>
<tr>
<td>- Develop a model to describe phenomena. (MS-PS4-2)</td>
<td>- A sound wave needs a medium through which it is transmitted. (MS-PS4-2)</td>
<td>- 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)</td>
</tr>
<tr>
<td><strong>Using Mathematics and Computational Thinking</strong></td>
<td><strong>PS4.B: Electromagnetic Radiation</strong></td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>- 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)</td>
<td>- Structures can be designed to serve particular functions. (MS-PS4-3)</td>
</tr>
<tr>
<td>- Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1)</td>
<td>- (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)</td>
<td><strong>Connections to Engineering, Technology, and Applications of Science</strong></td>
</tr>
<tr>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
<td><strong>PS4.C: Information Technologies and Instrumentation</strong></td>
<td></td>
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<tr>
<td>Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods.</td>
<td>- 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)</td>
<td><strong>Influence of Science, Engineering, and Technology on Society and the Natural World</strong></td>
</tr>
<tr>
<td>- 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)</td>
<td>- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (NYSED) However, because light can travel through space, it cannot be a mechanical wave, like sound or water waves. (MS-PS4-2)</td>
<td>- Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3)</td>
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<td><strong>Scientific Knowledge is Based on Empirical Evidence</strong></td>
<td><strong>Connections to Nature of Science</strong></td>
<td></td>
</tr>
<tr>
<td>- Science knowledge is based upon logical and conceptual connections between evidence and explanations (MS-PS4-1)</td>
<td>- Connections to other DCI's in this grade-band: MS.LS1.D (MS-PS4-2)</td>
<td><strong>Science is a Human Endeavor</strong></td>
</tr>
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<td><strong>Science and Engineering Practices</strong></td>
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<td>Articulation of DCIs across grade-bands: 4.PS3.A (MS-PS4-1); 4.PS3.B (MS-PS4-1); 4.PS4.A (MS-PS4-1); 4.PS4.B (MS-PS4-2); 4.PS4.C (MS-PS4-3); HS.PS4.A (MS-PS4-1),(MS-PS4-2),(MS-PS4-3); HS.PS4.B (MS-PS4-1),(MS-PS4-2); HS.PS4.C (MS-PS4-3); HS.ESS1.A (MS-PS4-2); HS.ESS2.A (MS-PS4-2); HS.ESS2.B (MS-PS4-2); HS.ESS2.D (MS-PS4-2)</td>
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<td><strong>PS4.A: Wave Properties</strong></td>
<td><strong>Connections to Nature of Science</strong></td>
<td></td>
</tr>
<tr>
<td>- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)</td>
<td>- Connections to other DCI's in this grade-band: MS.LS1.D (MS-PS4-2)</td>
<td></td>
</tr>
<tr>
<td><strong>PS4.B: Electromagnetic Radiation</strong></td>
<td><strong>New York State Next Generation Learning Standards Connections:</strong></td>
<td></td>
</tr>
<tr>
<td>- 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)</td>
<td><strong>ELA/Literacy -</strong></td>
<td></td>
</tr>
<tr>
<td>- (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)</td>
<td>6-8.RST.1</td>
<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-PS4-3)</td>
</tr>
<tr>
<td>- 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)</td>
<td>6-8.RST.2</td>
<td>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)</td>
</tr>
<tr>
<td>- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (NYSED) However, because light can travel through space, it cannot be a mechanical wave, like sound or water waves. (MS-PS4-2)</td>
<td>6-8.RST.9</td>
<td>Compare and contrast the information gained from two or more experiments, simulations, videos, multimedia sources, readings from texts, graphs, charts, et., on the same topic. (MS-PS4-3).</td>
</tr>
<tr>
<td><strong>PS4.C: Information Technologies and Instrumentation</strong></td>
<td>6-8.WHST.9</td>
<td>Draw evidence from informational texts to support analysis, reflection and research. (MS-PS4-3)</td>
</tr>
<tr>
<td>- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)</td>
<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-PS4-1),(MS-PS4-2)</td>
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<td><strong>Connections to Nature of Science</strong></td>
<td><strong>Mathematics -</strong></td>
<td></td>
</tr>
<tr>
<td>- Connections to other DCI's in this grade-band: MS.LS1.D (MS-PS4-2)</td>
<td>MP.2</td>
<td>Reason abstractly and quantitatively. (MS-PS4-1)</td>
</tr>
<tr>
<td><strong>Articulation of DCIs across grade-bands:</strong></td>
<td>MP.4</td>
<td>Model with mathematics. (MS-PS4-1)</td>
</tr>
<tr>
<td>4.PS3.A (MS-PS4-1); 4.PS3.B (MS-PS4-1); 4.PS4.A (MS-PS4-1); 4.PS4.B (MS-PS4-2); 4.PS4.C (MS-PS4-3); HS.PS4.A (MS-PS4-1),(MS-PS4-2),(MS-PS4-3); HS.PS4.B (MS-PS4-1),(MS-PS4-2); HS.PS4.C (MS-PS4-3); HS.ESS1.A (MS-PS4-2); HS.ESS2.A (MS-PS4-2); HS.ESS2.B (MS-PS4-2); HS.ESS2.D (MS-PS4-2)</td>
<td>NY-6.RP.1</td>
<td>Use ratio and rate reasoning to solve real-world mathematical problems. (MS-PS4-1)</td>
</tr>
<tr>
<td><strong>Science is a Human Endeavor</strong></td>
<td>NY-6.RP.3</td>
<td>Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS4-1)</td>
</tr>
<tr>
<td>- Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)</td>
<td>NY-7.RP.2</td>
<td>Recognize and represent proportional relationships between quantities. (MS-PS4-1)</td>
</tr>
<tr>
<td><strong>Connections to Nature of Science</strong></td>
<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-PS4-1)</td>
</tr>
</tbody>
</table>

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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-LS1-2)

**Planning and Carrying Out Investigations**
- Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.
  - Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. (MS-LS1-1)

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

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

### Disciplinary Core Ideas

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

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

### Crosscutting Concepts

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

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

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

**Interdependence of Science, Engineering, and Technology**
- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS1 1)

### Connections to Nature of Science

**Science is a Human Endeavor**
- Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-3)

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New York State P-12 Science Learning Standards

**MS. Matter and Energy in Organisms and Ecosystems**

Students who demonstrate understanding can:

**MS-LS1-6.** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assesses the biochemistry of photosynthesis.]

**MS-LS1-7.** Develop a model to describe how food molecules are rearranged through chemical reactions to release energy, during cellular respiration and/or form new molecules that support growth as this matter moves through an organism. [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for respiration or synthesis.]

**MS-LS2-1.** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

**MS-LS2-3.** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy associated with ecosystems, and on defining the boundaries of the ecosystem.] [Assessment Boundary: Assessment does not include the use of chemical equations to describe the processes.]

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

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### Science and Engineering Practices

**Developing and Using Models**

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

**Conducting Explanations and Designing Solutions**

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

**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-LS2-4)

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### 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 and water 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 each other for their environmental interactions with both other living things and with nonliving factors. (MS-LS1-6)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)

**LS2.B: Cycle of Matter and Energy Transfer in Ecosystems**

- Food webs are models that demonstrate how matter and energy are transferred between producers, consumers, and decomposers as the groups interact within an ecosystem. Transfomers of matter and energy interact in one system, and the flow of energy is greater in the system. (MS-LS1-6)

**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-LS1-6)
- Cellular respiration in plants and animals involves chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (MS-LS1-7)

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**Crosscutting Concepts**

**Cause and Effect**

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

**Energy and Matter**

- Matter is conserved because atoms are conserved in physical and chemical processes. (MS-LS1-7)
- Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)
- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

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### Connections to Nature of Science

**Scientific Knowledge**

Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through observation. (MS-LS2-3)

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*The performance expectations developed and the subject matter knowledge 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).*
<table>
<thead>
<tr>
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<tr>
<td><strong>ELA/Literacy</strong> - <strong>6-RST.1</strong></td>
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<tr>
<td><strong>6-RST.2</strong></td>
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<tr>
<td><strong>6-RST.7</strong></td>
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<tr>
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<td><strong>6-8.WHST.5</strong></td>
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</tr>
<tr>
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MS. 1. Interdependent Relationships in Ecosystems

### Core Ideas

**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.*

[Clarification Statement: Examples of ecosystem protections could include water purification, waste management, nutrient recycling, prevention of soil erosion, and eradication of invasive species. Examples of design solution constraints could include scientific, economic, and social considerations.]

*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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<tr>
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<tbody>
<tr>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td><strong>LS2.A: Interdependent Relationships in Ecosystems</strong></td>
<td><strong>Patterns</strong></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 ideas, principles, and theories.</td>
<td>• Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)</td>
<td>• Patterns can be used to identify cause and effect relationships. (MS-LS2-2)</td>
</tr>
<tr>
<td><strong>Engaging in Argument from Evidence</strong></td>
<td><strong>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</strong></td>
<td><strong>Stability and Change</strong></td>
</tr>
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<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>• (NYSED) Biodiversity describes the variety of species found in Earth’s ecosystems. The completeness or integrity of an ecosystem’s biodiversity is often used as a measure of its health. (MS-LS2-5)</td>
<td>• Small changes in one part of a system might cause large changes in another part. (MS-LS2-5)</td>
</tr>
<tr>
<td>• Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)</td>
<td><strong>LS4.D: Biodiversity and Humans</strong></td>
<td><strong>Connections to Engineering, Technology, and Applications of Science</strong></td>
</tr>
<tr>
<td><strong>ETS1.B: Developing Possible Solutions</strong></td>
<td>• Changes in biodiversity can influence humans’ resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.</td>
<td><strong>Influence of Science, Engineering, and Technology on Society and the Natural World</strong></td>
</tr>
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<td>• There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to MS-LS2-5)</td>
<td>(secondary to MS-LS2-5)</td>
<td>• The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-5)</td>
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</tbody>
</table>

*Connection boxes updated as of September 2018*

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### Science and Engineering Practices

**Constructing Explanations and Designing Solutions**

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

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

---

### Disciplinary Core Ideas

**LS2.A: Interdependent Relationships in Ecosystems**

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

**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**

- (NYSED) Biodiversity describes the variety of species found in Earth’s ecosystems. The completeness or integrity of an ecosystem’s biodiversity is often used as a measure of its health. (MS-LS2-5)
- Changes in biodiversity can influence humans’ resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (secondary to MS-LS2-5)
- Humans impact biodiversity both positively and negatively. (secondary to MS-LS2-5)

**ETS1.B: Developing Possible Solutions**

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

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### Crosscutting Concepts

**Patterns**

- Patterns can be used to identify cause and effect relationships. (MS-LS2-2)

**Stability and Change**

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

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

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

- The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-5)

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

- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)
### Science and Engineering Practices

<table>
<thead>
<tr>
<th>Developing and Using Models</th>
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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. | **LS1.B:** Growth and Development of Organisms  
- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-L5-2)  
- Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-L5-4)  
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-L5-4)  
- Genetic factors as well as local conditions affect the growth of the adult plant. (MS-L5-5) | **Cause and Effect**  
- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-L5-3)  
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-L5-1, MS-L5-2, MS-L5-4 - 5) |
| Engaging in Argument from Evidence | **LS3.A:** Inheritance of Traits  
- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene contribute to the production of specific proteins, which in turn affects the traits of the individual. (MS-L5-1)  
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-L5-2) | **Structure and Function**  
- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on their composition, organization, relationships among its parts, and how complex natural structures/systems can be analyzed to determine how they function. (MS-L5-3) |
| Obtaining, Evaluating, and Communicating Information | **LS3.B:** Variation of Traits  
- 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-L5-2)  
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-L5-3)  
- (NYSED) Mutations may result in changes to the structure and function of proteins. (MS-L5-3) | **Connections to Engineering, Technology, a Applications of Science**  
- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-L5-4 - 5) |
| Obtaining, evaluating, and communicating information in 6-8 builds on K-5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either arguments or ideas about phenomena. | **LS4.B:** Natural Selection  
- In artificial selection, humans use the capacity to influence certain characteristics of organisms. (NYSED)  
- Humans can be selective in their breeding practices to determine desired traits. Humans can be selective in their breeding practices to determine desired traits. (MS-L5-4) | **Connections to Nature of Science**  
- Scientific knowledge is incomplete, and describes the consequences of actions but does not necessarily prescribe the actions that society takes. (MS-L5-4) |

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<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-LS1-4),(MS-LS1-5),(MS-LS3-1),(MS-LS3-2),(MS-LS4-5)</th>
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<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-LS1-5)</td>
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<td>6-8.RST.4</td>
<td>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)</td>
<td></td>
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<td>6.R.8</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-LS3-1),(MS-LS3-2)</td>
<td></td>
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<tr>
<td>6-8.WHST.1</td>
<td>Write arguments focused on discipline content. (MS-LS1-4)</td>
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<td>6-8.WHST.2</td>
<td>Write informative/explanatory text focused on discipline-specific content. (MS-LS1-5)</td>
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<td>6-8.WHST.8</td>
<td>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)</td>
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<td>Draw evidence from informational texts to support analysis, reflection and research. (MS-LS1-5)</td>
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<td>NY-6.SP.2</td>
<td>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)</td>
<td></td>
</tr>
<tr>
<td>NY-6.SP.4</td>
<td>Display quantitative data in plots on a number line, including dot plots, and histograms. (MS-LS1-4),(MS-LS1-5)</td>
<td></td>
</tr>
<tr>
<td>NY-6.SP.5</td>
<td>Summarize quantitative data sets in relation to their context. (MS-LS3-2)</td>
<td></td>
</tr>
</tbody>
</table>

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

| Articulation to DCIs in this grade-band: MS.LS1.A (MS-LS3-1); MS.LS2.A (MS-LS1-4),(MS-LS1-5); MS.LS4.A (MS-LS3-1) |
| Articulation to DCIs across grade-bands: 3.LS1.B (MS-LS1-4),(MS-LS1-5); 3.LS3.A (MS-LS1-5),(MS-LS3-1),(MS-LS3-2); 3.LS3.B (MS-LS3-1),(MS-LS3-2); HS.LS1.A (MS-LS3-1),(MS-LS3-2); HS.LS1.B (MS-LS3-1),(MS-LS3-2); HS.LS2.A (MS-LS1-4),(MS-LS1-5); HS.LS2.D (MS-LS1-4); HS.LS3.A (MS-LS3-1),(MS-LS3-2); HS.LS3.B (MS-LS3-1),(MS-LS3-2),(MS-LS4-5); HS.LS4.C (MS-LS4-5) |

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*Connection boxes updated as of September 2018*
## MS. Natural Selection and Adaptations

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

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

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

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

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

### Science and Engineering Practices

**Analyzing and Interpreting Data**
- Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
  - Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1)
- Using Mathematics and Computational Thinking
  - Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.
  - Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6)

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

### Disciplinary Core Ideas

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

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

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

### Crosscutting Concepts

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

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

### Connections to Nature of Science

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

### Connections to Other Disciplines in this grade-band
- **MS.LS2.A** (MS-LS4-4), (MS-LS4-6), **MS.LS2.C** (MS-LS4-6); **MS.LS3.A** (MS-LS4-2), (MS-LS4-4); **MS.LS3.B** (MS-LS4-2), (MS-LS4-4), (MS-LS4-6); **MS.ESS1.C** (MS-LS4-1), (MS-LS4-2), (MS-LS4-6); **MS.ESS2.B** (MS-LS4-1), (MS-LS4-2)
- **Articulation of DCIs across grade-bands:** LS4-1, (MS-LS4-1), (MS-LS4-2); 3. **LS4.B** (MS-LS4-4); 3. **LS4.C** (MS-LS4-6); **HS.LS2.A** (MS-LS4-2), (MS-LS4-4), (MS-LS4-6); **HS.LS3.B** (MS-LS4-4), (MS-LS4-6); **HS.LS4.A** (MS-LS4-1), (MS-LS4-2), (MS-LS4-3), (MS-LS4-6); **HS.LS4.B** (MS-LS4-4), (MS-LS4-6); **HS.LS4.C** (MS-LS4-2), (MS-LS4-6); **HS.ESS1.C** (MS-LS4-1), (MS-LS4-2)

### New York State Next Generation Learning Standards Connections

**ELA/Literacy**
- **6-8.RST.1** Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-LS4-1), (MS-LS4-3), (MS-LS4-4)
- **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-LS4-1), (MS-LS4-3)
- **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-LS4-3), (MS-LS4-4)
- **6-8.WHS.T2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS4-2), (MS-LS4-4)
- **6-8.WHS.T9** **8SL.1** Engage effectively in a range of collaborative discussions with diverse partners; express ideas clearly and persuasively and build on those of others. (MS-LS4-2), (MS-LS4-4)
# New York State P-12 Science Learning Standards

**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*

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

**MS. Space Systems**

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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<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>ESS1.A: The Universe and Its Stars</strong></td>
<td>Patterns</td>
</tr>
<tr>
<td>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>• Patterns 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)</td>
<td>• Patterns can be used to identify cause and effect relationships. (MS-ESS1-1)</td>
</tr>
<tr>
<td>and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.</td>
<td>• Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)</td>
<td><strong>Scale, Proportion, and Quantity</strong></td>
</tr>
<tr>
<td><strong>Analyzing and Interpreting Data</strong></td>
<td>• 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)</td>
<td>• 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)</td>
</tr>
<tr>
<td>Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.</td>
<td>• The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)</td>
<td><strong>Systems and System Models</strong></td>
</tr>
<tr>
<td>• Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3)</td>
<td></td>
<td>• Models can be used to represent systems and their interactions. (MS-ESS1-2)</td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th>Connections to other DCIs in this grade-band:</th>
<th><strong>Articulation of DCIs across grade-bands:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MS-ESS1-1),(MS-ESS1-2); MS-ESS2.A (MS-ESS1-3)</strong></td>
<td><strong>3.PS2.A (MS-ESS1-1),(MS-ESS1-2); 5.PS2.B (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3); MS-ESS2.A (MS-ESS1-3)</strong></td>
</tr>
<tr>
<td><strong>MS-ESS1-1),(MS-ESS1-2); MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3); MS-ESS2.A (MS-ESS1-3)</strong></td>
<td><strong>5.ESS1.A (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3); 5.ESS1.B (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3); 5.ESS2.A (MS-ESS1-3); HS-ESS1.B (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3); HS-ESS1.C (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3); HS-ESS2.A (MS-ESS1-3)</strong></td>
</tr>
</tbody>
</table>

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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** I 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 situations. (MS-ESS1-2)

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

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**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 the 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 particular 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 geochemical 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.]

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**Science and Engineering Practices**

**Analyzing and Interpreting Data**

Analyzing data in 6-8 builds on K-5 and progresses to 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 the Earth or the earliest evidence of life). Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)

**Construcion of Explanations and Designing Solutions**

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

**Informing and Designing Solutions**

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

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**Disciplinary Core Ideas**

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

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

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

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

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

- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth’s plates have moved great distances, collided, and spread apart. (MS-ESS2-2)

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

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

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**Crosscutting Patterns**

- Patterns in rates of change and other numerical relationships can provide information about natural systems. (MS-ESS2-3)

**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-ESS1-4), (MS-ESS2-2)

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**Connections to Nature of Science**

**Scientific Knowledge is Open to Revision in Light of New Evidence**

- Science findings are frequently revised and/or reinterpreted based on new evidence. (MS-ESS2-3)

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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-ESS1-4), (MS-ESS2-2), (MS-ESS2-3)
- 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-ESS2-3)
- 6-8.RST.9 Compare and contrast the information gained from two or more experiments, simulations, videos, multimedia sources, readings from texts, graphs, charts, etc., on the same topic. (MS-ESS2-3)
- 6-8.WHST.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS1-4), (MS-ESS2-2)
- 8.SL.5 Integrate digital media and/or visual displays in presentations to clarify information, strengthen claims and evidence, and add elements of interest or engage the audience. (MS-ESS2-2)

**Mathematics:**

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

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The performance expectations above were developed using the following elements from the NRC's document *A Framework for K-12 Science Education*. The "Disciplinary Core Ideas" section is reproduced verbatim from *A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas* unless it is preceded by (NYSED).
New York State P-12 Science Learning Standards

**MS. Weather and Climate**

Students who demonstrate understanding can:

**MS-ESS2-5.** Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. [Clarification Statement: Emphasis is on how air flows from regions of high pressure to low pressure, the complex interactions at air mass boundaries, and the movements of air masses affect weather (defined by temperature, pressure, humidity, precipitation, and wind at a fixed location 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 geography and distribution. Emphasis is on the sun-driven, latitudinal banding causing differences in density that create convection currents in the atmosphere, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean 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.]

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

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### Science and Engineering Practices

**Asking Questions and Defining Problems**

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

- Develop and use a model to describe phenomena. (MS-ESS2-6)

**Planning and Carrying Out Investigations**

Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.

- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)

### Disciplinary Core Ideas

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

- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and oceanic and atmospheric circulation that determine regional climates.

**ESS2.D: Weather and Climate**

- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions are determined by latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.

**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)

### Articulation of DCIs across grade levels


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

**ELA/Literacy**

- **6-8.RST.1** Cite specific textual evidence to support analysis of science and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions. (MS-ESS2-5), (MS-ESS3-5)

- **6-8.RST.9** Compare and contrast the information gained from two or more experiments, simulations, videos, multimedia sources, readings from texts, graphs, charts, etc., on the same topic. (MS-ESS2-5), (MS-ESS3-5)

- **6-8.WHST.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source by applying discipline specific criteria used in the social sciences or sciences, and quote or paraphrase the data/accounts and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS2-5), (MS-ESS3-5)

**Mathematics**

- **MP.2** Reason abstractly and quantitatively. (MS-ESS2-5), (MS-ESS3-5)

- **NY-6.NS.5** Understand that positive and negative numbers are used together to describe quantities having opposite directions or values. Use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5), (MS-ESS3-5)

- **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-ESS2-5), (MS-ESS3-5)

- **NY-7.EE.4** Use properties of operations to reasons about the quantities. (MS-ESS2-5), (MS-ESS3-5)

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Students who demonstrate understanding can:

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

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

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

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

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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 including 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 any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-2), (MS-ESS3-3)

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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/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-ESS3-2), (MS-ESS3-4)

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-ESS3-2)

6-8.WHST.1  Write arguments focused on discipline content. (MS-ESS3-4)

6-8.WHST.7  Conduct short research projects to answer a question (including a self-generated question by the end of grade 8), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ESS3-3)

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, and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS3-3)

6-8.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></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MP.2</strong></td>
<td>Reason abstractly and quantitatively. (MS-ESS3-2)</td>
</tr>
<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
### MS. Engineering Design

Students who demonstrate understanding can:

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

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

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

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

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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<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking Questions and Defining Problems</td>
<td>ETS1A: Defining and Delimiting Engineering Problems</td>
<td>Influence of Science, Engineering, and Technology on Society and the Natural World</td>
</tr>
<tr>
<td>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.</td>
<td>• The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)</td>
<td>• 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)</td>
</tr>
<tr>
<td>Defining a design problem that can be solved through the development of an object, tool, or process, and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)</td>
<td>ETS1B: Developing Possible Solutions</td>
<td>• 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-ETS1-3)</td>
</tr>
<tr>
<td>Developing and Using Models</td>
<td>• A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)</td>
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<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>• There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2),(MS-ETS1-3)</td>
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<tr>
<td>• Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)</td>
<td>• Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)</td>
<td></td>
</tr>
<tr>
<td>Analyzing and Interpreting Data</td>
<td>Models of all kinds are important for testing solutions. (MSETS1-4)</td>
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<tr>
<td>Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.</td>
<td>ETS1C: Optimizing the Design Solution</td>
<td></td>
</tr>
<tr>
<td>• Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)</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 those characteristics may be incorporated into the new design. (MS-ETS1-3)</td>
<td></td>
</tr>
<tr>
<td>Engaging in Argument from Evidence</td>
<td>• 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)</td>
<td></td>
</tr>
<tr>
<td>Engaging in argument from evidence in 6-8 builds on K-5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.</td>
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<tr>
<td>• Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)</td>
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</table>

Connections to MS-ETS1A: Defining and Delimiting Engineering Problems include:
- **Physical Science:** MS-PS3-3
- **Life Science:** MS-LS2-5

Connections to MS-ETS1B: Developing Possible Solutions Problems include:
- **Physical Science:** MS-PS1-6, MS-PS3-3
- **Life Science:** MS-LS2-5

Connections to MS-ETS1C: Optimizing the Design Solution include:
- **Physical Science:** MS-PS1-6

Articulation of DCIs across grade-bands: 3-5.ETS1A (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3), 3-5.ETS1B (MS-ETS1-2), (MS-ETS1-3), (MS-ETS1-4), 3-5.ETS1C (MS-ETS1-3), (MS-ETS1-4), 6-8.ETS1A (MS-ETS1-1), (MS-ETS1-2), 6.ETS1B (MS-ETS1-1), (MS-ETS1-2), 6.ETS1C (MS-ETS1-3), (MS-ETS1-4), 8.SL.5

**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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<table>
<thead>
<tr>
<th>NY-7.EE.3</th>
<th>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. <em>(MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)</em></th>
</tr>
</thead>
</table>

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

HS. Structure and Properties of Matter

Students who demonstrate understanding can:

**HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.** [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [Assessment Boundary: Assessment does not include quantitative understanding of ionization energy beyond relative trends.]

**HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.** [Clarification Statement: Emphasis is on understanding the forces of interaction between substances where the forces are determined by solids, liquids, and gases. Not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and network solids. Examples of bulk scale properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.]

**HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.** [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams. Assessment of calculation of energy released is limited to alpha, beta, positron, and gamma radioactive decay.]

**HS-PS2-6. Communicate scientific and technical information about why the particulate-level structure is important in the functioning of designed materials.** [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.]

**HS-PS1-9. Analyze data to support the claim that the combined gas law describes the relationships among volume, pressure, and temperature for a sample of an ideal gas.** [Clarification Statement: Real gases may be included at conditions near STP. The relationships of the variables in the combined gas law may be described both qualitatively and quantitatively.] [Assessment Boundary: Assessment is limited to the relationships among the variables of the combined gas law, not the law gas names, i.e. Boyle’s Law.]

**HS-PS1-10. Use evidence to support claims regarding the formation, properties, and behaviors of solutions at bulk scales.** [Clarification Statement: Examples of physical properties could include colligative properties, degree of saturation, physical behavior of solutions, solution process and conductivity. Examples of solution types could include solid-liquid, liquid-liquid, and gas-liquid solutions. Concentrations can be quantitatively expressed in ppm, molarity, and percent by mass.]

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 9-12 builds on K-8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
  - Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-8)
  - Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

**Planning and Carrying Out Investigations**
- Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
  - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3)

**Analyzing and Interpreting Data**
- Analyzing data in 9-12 builds on K-8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
  - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS1-9)

**Engaging in Argument from Evidence**
- Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.
  - Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS1-10)

**Obtaining, Evaluating, and Communicating Information**
- Obtaining, evaluating, and communicating information in 9-12 builds on K-8 and progresses to evaluate the validity and

### Disciplinary Core Ideas

**PS1.A: Structure and Properties of Matter**
- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1)
- The structure and interactions of matter at the bulk scale are determined by spherical electrical forces within and between atoms. (HS-PS1-3), (secondary to HS-PS2-6)
- The concept of an ideal gas is a model to explain behavior of gases. A real gas is most like an ideal gas when the real gas is at low pressure and high temperature. HS-PS1-9
- Solutions possess characteristic properties that can be described quantitatively and qualitatively. (HS-PS1-10)

**PS1.B: Nuclear Processes**
- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8)

**PS2.B: Types of Interactions**
- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (secondary to HS-PS1-1), (secondary to HS-PS1-3), (HS-PS2-6).

### Crosscutting Concepts

**Patterns**
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-1), (HS-PS1-3), (HS-PS1-10)
- Mathematical representations can be used to identify certain patterns. (HS-PS1-9)

**Energy and Matter**
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8)

**Structure and Function**
- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)
reliability of the claims, methods, and designs.

* Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)


Articulation of DCIs across grade-bands: **MS.PS1.A** (HS-PS1-1), **HS.PS1-3** (HS-PS1-3), **HS.PS1-8** (HS-PS1-3), **HS.PS2-6** (HS-PS2-6), **MS.PS2.A** (HS-PS1-8)

New York State Next Generation Learning Standards:

**ELA/Literacy – 9-10.RST.7**
Translate scientific or technical information expressed as written text into visual form (e.g., a table or chart), and translate information expressed visually or mathematically (e.g., in an equation) into words. (HS-PS1-1)

**11-12.RST.1**
Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attending to the precise details of the source, and attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3), (HS-PS1-10), (HS-PS2-6)

**9-10.WHST.2**
Write informative/explanatory text focused on discipline-specific content. (HS-PS1-3)

**11-12.WHST.2**
Write explanatory and analytical text focused on discipline-specific content and which uses strategies for conveying information like those used in the respective discipline. (HS-PS1-3)

**9-12.WHST.5**
Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3), (HS-PS1-10)

**11-12.WHST.6**
Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience as well as by applying discipline-specific criteria used in the social sciences or sciences; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3), (HS-PS1-9)

**Mathematics – MP.4**
Model with Mathematics. (HS-PS1-8), (HS-PS1-9)

**AI-N.Q.1**
Select quantities and use units as a way to: i) interpret and guide the solution of multi-step problems; ii) choose and interpret units consistently in formulas; and iii) choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-3), (HS-PS1-8), (HS-PS1-9), (HS-PS1-6).

**AI-N.Q.3**
Choose a level of accuracy appropriate to limitations on measurement and context when reporting quantities. (HS-PS1-3), (HS-PS1-8), (HS-PS1-10), (HS-PS2-6)

*Connection boxes updated as of September 2018

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New York State P-12 Science Learning Standards

HS. Chemical Reactions

Students who demonstrate understanding can:

HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.]

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]

HS-PS1-5. Apply scientific principles and evidence to explain how the rate of a physical or chemical change is affected when conditions are varied. [Clarification Statement: Explanations should be based on three variables in collision theory: number of collisions per unit time, particle orientation on collision, and energy required to produce the change. Conditions that affect these three variables include temperature, pressure, nature of reactants, concentrations of reactants, mixing, particle size, surface area, and addition of a catalyst.] [Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants and to specifying the change in only one condition at a time.]

HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. [Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to identifying conditions that affect the equilibrium and not the design.]

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include calculating equilibrium constants and concentrations.]

HF-PS1-11. Plan and conduct an investigation to compare properties and behaviors of acids and bases. [Clarification Statement: Examples of properties could include pH values (concentration), neutralization capability and conductivity. Observations of behaviors could include the effects on indicators, reactions with other substances, and efficacy in performing titrations.] [Assessment Boundary: Reactions are limited to Arrhenius and Bronsted-Lowry acid-base reactions.]

HF-PS1-12. Use evidence to illustrate that some chemical reactions involve the transfer of electrons as an energy conversion occurs within a system. [Clarification Statement: Evidence could include half-reactions, net ionic equations, and electrochemical cells to illustrate the mechanism of electron transfer.] [Assessment Boundary: Assessment is limited to completing and/or balancing oxidation and reduction half-reactions. Energy conversion is limited to qualitative statements.]

Science and Engineering Practices

Developing and Using Models
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-11)
- Select appropriate tools to collect, record, analyze, and evaluate data. (HS-PS1-11)

Using Mathematics and Computational Thinking
Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analyses to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
- Use mathematical representations of phenomena to support claims. (HS-PS1-7)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible

Disciplinary Core Ideas

- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-2) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)
- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)

PS1.B: Chemical Reactions
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2), (HS-PS1-7)
- (NYSED) Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of particles and the rearrangements of particles into new substances, with consequent changes in the sum of all bond energies in the set of substances that are matched by changes in energy. (HS-PS1-4), (HS-PS1-5)
- (NYSED) In many situations, a dynamic and condition dependent balance between a reaction and the reverse reaction determines the numbers of all types of particles present. (HS-PS1-6)
- (NYSED) Acids and bases play an important role in the daily lives of humans and other organisms (e.g. agricultural applications, environmental impacts (acid rain), animal and plant physiology). (HS-PS1-11)
- (NYSED) Oxidation-reduction reactions are the

Crosscutting Concepts

Patterns
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-2), (HS-PS1-5), (HS-PS1-11)

Energy and Matter
- The total amount of energy and matter in closed systems is conserved. (HS-PS1-7), (HS-PS1-12)
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4), (HS-PS1-12)

Stability and Change
- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7)

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The text in the “Disciplinary Core Ideas” section is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas unless it is preceded by (NYSED).
New York State P-12 Science Learning Standards

- unanticipated effects. (HS-PS1-5)
- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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. (HS-PS1-2)
- Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)

Engaging in Argument from Evidence
Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS1-12)

Connections to other DCIs in this grade-band: HS.PS3.A (HS-PS1-4),(HS-PS1-5); HS.PS3.B (HS-PS1-5),(HS-PS1-7); HS.PS3.D (HS-PS1-4); HS.LS1.C (HS-PS1-4),(HS-PS1-7); HS.LS2.B (HS-PS1-7); HS.LS2.A (HS-PS1-7)

Articulation of DCIs across grade-bands: MS.PS1.A (HS-PS1-2),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7); MS.PS1.B (HS-PS1-2),(HS-PS1-4),(HS-PS1-5),(HS-PS1-6),(HS-PS1-7); MS.PS2.B (HS-PS1-3),(HS-PS1-4),(HS-PS1-5); MS.PS3.A (HS-PS1-5); MS.PS3.B (HS-PS1-5); MS.PS3.D (HS-PS1-4); MS.LS1.C (HS-PS1-4),(HS-PS1-7); MS.LS2.B (HS-PS1-7); MS.ESS2.A (HS-PS1-7)

New York State Next Generation Learning Standards:
ELA/Literacy –
11-12.RST. 1 Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attending to the precise details of the source, and attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-5)
9-10.WHST.2 Write informative/explanatory text focused on discipline-specific content. (HS-PS1-5)
11-12.WHST.2 Write explanatory and analytical text focused on discipline-specific content and which uses strategies for conveying information like those used in the respective discipline. (HS-PS1-2),(HS-PS1-5)
9-12.WHST.5 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-6), (HS-PS1-11)
11-12.SL.5 Make strategic use of digital media and/or visual displays in presentations to enhance understanding of findings, reasoning, and evidence, and to add elements of interest to engage the audience. (HS-PS1-4),(HS-PS1-12)

Mathematics –
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7),(HS-PS1-12)
MP.4 Model with Mathematics. (HS-PS1-4),(HS-PS1-11)
AI-N.Q.1 Select quantities and use units as a way to: i) interpret and guide the solution of multi-step problems; ii) choose and interpret units consistently in formulas; and iii) choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-11)
AI-N.Q.3 Choose a level of accuracy appropriate to limitations on measurement and context when reporting quantities. (HS-PS1-2),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7)

*Connection boxes updated as of September 2018

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HS. Forces and Interactions

Science and Engineering Practices

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design of experiments, decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-5)

Analyzing and Interpreting Data
Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS2-1)

Using Mathematics and Computational Thinking
Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical representations of phenomena to describe explanations. (HS-PS2-2),(HS-PS2-4)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3)

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

- Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4)

Disciplinary Core Ideas

PS2.A: Forces and Motion
- Newton’s second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)
- Momentum is defined for a particular frame of reference: it is the mass times the velocity of the object. (HS-PS2-2)
- If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3)

PS2.B: Types of Interactions
- Newton’s law of universal gravitation and Coulomb’s law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)
- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5)

ETS1.A: Defining and Delimiting Engineering Problems
- Criteria and constraints also include satisfying requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3)

ETS1.C: Optimizing the Design Solution
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS2-3)

Crosscutting Concepts

Patterns
- Different patterns may be observed at each of the scales at which a phenomenon is studied and can provide evidence for causality in explanations of phenomena. (HS-PS2-4)

Cause and Effect
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1),(HS-PS2-5)
- Systems can be designed to cause a desired effect. (HS-PS2-3)

Systems and System Models
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)

New York State Next Generation Learning Standards

ELA/Literacy

11–12.RST. 1  Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attending to the precise details of the source, and attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS2-1)
11–12.RST.7  Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)
9–12.WHST.5  Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1)
11–12.WHST.6  Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience as well as by applying discipline specific criteria used in the social sciences or sciences;

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

**11-12.WHST.7**  
**Mathematics –**

<table>
<thead>
<tr>
<th>Code</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-12.WHST.7</td>
<td>Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1), (HS-PS2-5)</td>
</tr>
<tr>
<td>MP.2</td>
<td>Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)</td>
</tr>
<tr>
<td>MP.4</td>
<td>Model with Mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)</td>
</tr>
<tr>
<td>AI-N.Q.1</td>
<td>Select quantities and use units as a way to: i) interpret and guide the solution of multi-step problems; ii) choose and interpret units consistently in formulas; and iii) choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)</td>
</tr>
<tr>
<td>AI-N.Q.3</td>
<td>Choose a level of accuracy appropriate to limitations on measurement and context when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5)</td>
</tr>
<tr>
<td>AI-SSE.1</td>
<td>Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-2)</td>
</tr>
<tr>
<td>AI-SSE.3</td>
<td>Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1),(HS-PS2-2)</td>
</tr>
<tr>
<td>AI.CED.1</td>
<td>Create equations and inequalities in one variable to represent a real-world context. (HS-PS2-1),(HS-PS2-2)</td>
</tr>
<tr>
<td>AI.CED.2</td>
<td>Create equations and linear inequalities in two variables to represent a real-world context. (HS-PS2-1),(HS-PS2-2)</td>
</tr>
<tr>
<td>AI.CED.4</td>
<td>Rewrite formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)</td>
</tr>
<tr>
<td>AI-F.IF.7</td>
<td>Graph functions and show key features of the graph by hand and by using technology where appropriate. (HS-PS2-1)</td>
</tr>
<tr>
<td>AI-S.ID.1</td>
<td>Represent data with plots on the real number line (dot plots, histograms, and box plots). (HS-PS2-1)</td>
</tr>
</tbody>
</table>

*Connection boxes updated as of September 2018*

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New York State P-12 Science Learning Standards

HS. Energy

Students who demonstrate understanding can:

**HS-PS3-1.** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions for energy, work, and power used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to work, power, thermal energy, kinetic energy, potential energy, light energy, in gravitational, magnetic, electric, and chemical fields.]

**HS-PS3-2.** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above Earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.]

**HS-PS3-3.** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, loud or light meters, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input.]

**HS-PS3-4.** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system. (second law of thermodynamics). [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both qualitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.]

**HS-PS3-5.** Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. [Clarification Statement: Examples of models could include diagrams, texts, algebraic expressions, and drawings representing what happens when two charges of opposite polarity are near each other.] [Assessment Boundary: Assessment is limited to devices constructed with materials provided to students.]

**HS-PS3-6.** Analyze data to support the claim that Ohm’s Law describes the mathematical relationship among the potential difference, current, and resistance of an electric circuit. [Clarification Statement: Emphasis should be on arrangements of series circuits and parallel circuits using conventional current.] [Assessment Boundary: Assessment is limited to direct current (DC) circuits.]

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<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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<tbody>
<tr>
<td>Developing and Using Models</td>
<td>PS3.A: Definitions of Energy</td>
<td>Patterns</td>
</tr>
<tr>
<td>Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.</td>
<td>Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system.</td>
<td>Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS3-6)</td>
</tr>
<tr>
<td>Planning and Carrying Out Investigations</td>
<td>At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2)</td>
<td>Mathematical representations can be used to identify certain patterns. (HS-PS3-6)</td>
</tr>
<tr>
<td>Analyzing and Interpreting Data</td>
<td>These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept, that of radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)</td>
<td>Cause and Effect</td>
</tr>
<tr>
<td>PS3.B: Conservation of Energy and Energy Transfer</td>
<td>Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)</td>
<td>Changes and feedback relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the larger system. (HS-PS3-4)</td>
</tr>
<tr>
<td>Using Mathematics and Computational Thinking</td>
<td>Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring, and how kinetic energy depends on mass and speed), allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)</td>
<td>Models can be used to predict the behavior of a system, but these predictions can have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1)</td>
</tr>
<tr>
<td>Analyzing data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS3-6)</td>
<td>The availability of energy limits what can occur in any system. (HS-PS3-1)</td>
<td>Energy and Matter</td>
</tr>
<tr>
<td>Using Mathematics and Computational Thinking</td>
<td>Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)</td>
<td>Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS3-3)</td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>(NYSED) Energy exists in many forms, and when these forms change, energy is conserved. (HS-PS3-6)</td>
<td>Energy can be transferred between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2),(HS-PS3-6)</td>
</tr>
</tbody>
</table>

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## New York State P-12 Science Learning Standards

<table>
<thead>
<tr>
<th>Connections to other DCIs in this grade band:</th>
<th>Articulation of DCIs across grade bands:</th>
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### Connections to Engineering, Technology, and Applications of Science

**Influence of Science, Engineering, and Technology on Society and the Natural World**
- Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3)

### Connections to Nature of Science

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**
- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)

### New York State Next Generation Learning Standards: ELA/Literacy –

**9-12.RST.1**
Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attending to the precise details of the source, and attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS3-1), (HS-PS3-2), (HS-PS3-4), (HS-PS3-6)

**11-12.WHST.5**
Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS3-3), (HS-PS3-4), (HS-PS3-5)

**11-12.WHST.6**
Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience as well as by applying discipline specific criteria used in the social sciences or sciences; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS3-4), (HS-PS3-5)

**11-12.WHST.7**
Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS3-4), (HS-PS3-5), (HS-PS3-6)

**11-12.SL.5**
Make strategic use of digital media and/or visual displays in presentations to enhance understanding of findings, reasoning, and evidence, and to add elements of interest to engage the audience. (HS-PS3-1), (HS-PS3-2), (HS-PS3-5)

### Mathematics –

**MP.2**
Reason abstractly and quantitatively. (HS-PS3-1), (HS-PS3-2), (HS-PS3-3), (HS-PS3-4), (HS-PS3-5), (HS-PS3-6)

**MP.4**
Model with Mathematics. (HS-PS3-1), (HS-PS3-2), (HS-PS3-3), (HS-PS3-4), (HS-PS3-5), (HS-PS3-6)

**AI-N.Q.1**
Select quantities and use units as a way to: i) interpret and guide the solution of multi-step problems; ii) choose and interpret units consistently in formulas; and iii) choose and interpret the scale and the origin in graphs and data displays. (HS-PS3-1), (HS-PS3-3), (HS-PS3-6)

**AI-N.Q.3**
Choose a level of accuracy appropriate to limitations on measurement and context when reporting quantities. (HS-PS3-1), (HS-PS3-3)

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

**HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the period, frequency, wavelength, and speed of waves traveling and transferring energy (amplitude, frequency) in various media.** (Clarification Statement: Examples of data could include descriptions of waves classified as transverse, longitudinal, mechanical, or standing, electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, seismic waves traveling through Earth, and direction of waves due to reflection and refraction.) (Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.)

**HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.** (Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.)

**HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model (quantum theory), and that for some situations one model is more useful than the other.** (Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and the photoelectric effect.) (Assessment Boundary: Assessment of the photoelectric effect is limited to qualitative descriptions.)

**HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** (Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include scientific journals, trade books, magazines, web resources, videos, and other passages that may reflect bias.) (Assessment Boundary: Assessment is limited to qualitative descriptions.)

**HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* (Clarification Statement: Examples could include Doppler effect, solar cells capturing light and converting it to electricity, medical imaging, and communications technology.) (Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.)

**HS-PS4-6. Use mathematical models to determine relationships among the size and location of images, size and location of objects, and focal lengths of lenses and mirrors.** (Clarification Statement: Emphasis should be on analyzing ray diagrams to determine image size and location.) (Assessment Boundary: Assessment is limited to analysis of plane, convex, and concave mirrors, and biconvex and biconcave lenses.)

### Science and Engineering Practices

**Asking Questions and Defining Problems**
- Asking questions and defining problems in grades 9-12 builds on K-8 and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
- Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (HS-PS4-2)

**Using Mathematics and Computational Thinking**
- Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS4-6)

**Engaging in Argument from Evidence**
- Engaging in argument from evidence in grades 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.
- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS4-3)

**Obtaining, Evaluating, and Communicating Information**
- Obtaining, evaluating, and communicating information in 9-12 builds on K-8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.
- Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4)
- Communicate technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS4-5)

### Disciplinary Core Ideas

**PS3.D: Energy**
- Solar cells are human-made devices that likewise capture the sun’s energy and produce electrical energy. (secondary to HS-PS4-5)

**PS4.A: Wave Properties**
- The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1)
- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2, HS-PS4-5)
- [From the 3-5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only. It can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3)
- [NYSED] The location and size of an image are related to the location and size of an object for a plane mirror. The location and size of an image (real or virtual) are related to the location and size of an object and the focal distance for convex and concave mirrors. (HS-PS4-5)
- [NYSED] The location and size of an image (real or virtual) are related to the location and size of an object and the focal distance for biconvex and biconcave lenses. (HS-PS4-6)

**PS4.B: Electromagnetic Radiation**
- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3)
- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.

### Crosscutting Concepts

**Patterns**
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS4-6)
- Mathematical representations can be used to identify certain patterns. (HS-PS4-6)

**Cause and Effect**
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-3)
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by analogy to what is known about smaller scale mechanisms within the system. (HS-PS4-4)
- Systems can be designed to cause a desired effect. (HS-PS4-5)

**Systems and System Models**
- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-PS4-3)

**Stability and Change**
- Systems can be designed for greater or lesser stability. (HS-PS4-2)

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

**Interdependence of Science, Engineering, and Technology**
- Science and engineering complement each other in the cycle known as research and development (R&D). (HS-PS4-5)

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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

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

#### Connection to Nature of Science

**Science Models, Laws, Mechanisms, and Theories**

- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-PS4-3)

**PS4.C: Information Technologies and Instrumentation**

- Photovoltaic materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5)

### New York State Next Generation Learning Standards:

**Mathematics**

- MP.2 Reason abstractly and quantitatively. (HS-PS4-1),(HS-PS4-3),(HS-PS4-6)
- MP.4 Model with Mathematics. (HS-PS4-1),(HS-PS4-3)
- AI.SSE.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS4-1),(HS-PS4-3),(HS-PS4-6)
- AI.SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1),(HS-PS4-3),(HS-PS4-6)
- AI.CED.4 Rewrite formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1),(HS-PS4-3),(HS-PS4-6)

**ELA/Literacy**

- 9-10.RST.4 Assess the extent to which the reasoning and evidence in a source support the author’s claim or a recommendation for solving a scientific or technical problem. (HS-PS4-2),(HS-PS4-3)
- 11-12.RST.1 Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attending to the precise details of the source, and attending to important distinctions the author makes to any gaps or inconsistencies in the account. (HS-PS4-2),(HS-PS4-3)
- 11-12.RST.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS4-2),(HS-PS4-3)
- 11-12.RST.8 Evaluate the data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-PS4-2),(HS-PS4-3)
- 9-10.WHST.2 Write explanatory and analytical text focused on discipline-specific content and which uses strategies for conveying information like those used in the respective discipline. (HS-PS4-5)
- 11-12.WHST.2 Write informative/explanatory text focused on discipline-specific content. (HS-PS4-5)
- 11-12.WHST.6 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience as well as by applying discipline specific criteria used in the social sciences or sciences; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS4-4)

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

- Modern civilization depends on major technological systems. (HS-PS4-2)
- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS4-2)

### Articulation of DCIs across grade-bands

- **HS.PS1.C** (HS-PS4-4)
- **HS.PS3.A** (HS-PS4-4)
- **HS.PS3.D** (HS-PS4-4)
- **HS.PS3.A** (HS-PS4-4)
- **HS.LS1.C** (HS-PS4-4)

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New York State P-12 Science Learning Standards

HS. Structure and Function

Students who demonstrate understanding can:

**HS-LS1-1.** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. [Clarification Statement: Emphasis should be on how the DNA code is transcribed and translated in the synthesis of proteins. Types of proteins involved in performing life functions include enzymes, structural proteins, cell receptors, hormones, and antibodies.] [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the detailed biochemistry of protein synthesis.]

**HS-LS1-2.** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism's system level such as nutrient uptake, water delivery, immune response, and organism response to stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]

**HS-LS1-3.** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.]

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 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world.

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)

**Planning and Carrying Out Investigations**

Planning and carrying out in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3)

**Constructing Explanations and Designing Solutions**

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-LS1-1)

### Disciplinary Core Ideas

**LS1A: Structure and Function**

- Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1)
- Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)
- Feedback mechanisms maintain a living system’s internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)
- Disease is not a failure of homeostasis. Organisms have a variety of mechanisms to prevent and combat disease. (HS-LS1-3)

**LS1B: Systems and System Models**

- Systems (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)

### Crosscutting Concepts

**Systems and System Models**

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)

**Stability and Change**

- Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

### Connections to Nature of Science

**Scientific Investigations Use a Variety of Methods**

Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

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HS. Matter and Energy in Organisms and Ecosystems

Science and Engineering Practices

Developing and Using Models
Modeling in 9–12 builds on K–8 experiences and progressions to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7)
- Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)

Using Mathematics and Computational Thinking
Mathematical and computational thinking in 9–12 builds on K–8 experiences and progressions to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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. (HS-LS1-5),(HS-LS2-3)

Disciplinary Core Ideas

- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. (HS-LS1-6),(HS-LS1-7)
- (NYSED) Sugar molecules contain carbon, hydrogen, and oxygen. Their hydrocarbon backbones combine with other elements to make amino acids and other carbon-based molecules that can be assembled into larger molecules, such as proteins or DNA. (HS-LS1-6)
- (NYSED) Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed. In this process ATP is produced, which is used to carry out life processes. (HS-LS1-7)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)
- Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)
- (NYSED) When matter is cycled through organisms and ecosystems, some of the matter reacts to release energy for life functions, some is stored in newly made structures, and some is eliminated as waste. (HS-LS2-4)

Crosscutting Concepts

Systems and System Models
Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-3)

Energy and Matter
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5),(HS-LS1-6)
- Energy can be transferred between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4)
- Energy drives the cycling of matter within and between systems. (HS-LS2-3)

Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence
- Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-3)

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**Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, hydrosphere, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5)**

**PS3.D: Energy in Chemical Processes**
- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5)

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

**Articulation of DCIs across grade-bands:**
- MS.PS1.A (HS-LS1-6); MS.PS1.B (HS-LS1-5),(HS-LS1-6),(HS-LS1-7),(HS-LS2-3); MS.PS3.D (HS-LS1-5),(HS-LS1-6),(HS-LS1-7),(HS-LS2-3),(HS-LS2-4),(HS-LS2-5); MS.LS1.C (HS-LS1-5),(HS-LS1-6),(HS-LS1-7),(HS-LS2-3),(HS-LS2-4),(HS-LS2-5); MS.LS2.B (HS-LS1-5),(HS-LS1-7),(HS-LS2-3),(HS-LS2-4),(HS-LS2-5); MS.ESS2.A (HS-LS2-5); MS.ESS2.E (HS-LS1-6)

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

**ELA/Literacy** -
- **11-12.RST.1** Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attending to the precise details of the source, and attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-6),(HS-LS2-3)
- **9-10.WHST.2** Write informative/explanatory text focused on discipline-specific content. (HS-LS1-6),(HS-LS2-3)
- **11-12.WHST.2** Write explanatory and analytical text focused on discipline-specific content and which uses strategies for conveying information like those used in the respective discipline. (HS-LS1-6),(HS-LS2-3)
- **9-12.WHST.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-6)
- **11-12.SL.5** Make strategic use of digital media and/or visual displays in presentations to enhance understanding of findings, reasoning, and evidence, and to add elements of interest to engage the audience. (HS-LS1-5),(HS-LS1-7)

**Mathematics** -
- **MP.2** Reason abstractly and quantitatively. (HS-LS2-4)
- **MP.4** Model with Mathematics. (HS-LS2-4)
- **AI-N.Q.1** Select quantities and use units as a way to: i) interpret and guide the solution of multi-step problems; ii) choose and interpret units consistently in formulas; and iii) choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-4)
- **AI-N.Q.3** Choose a level of accuracy appropriate to limitations on measurement and context when reporting quantities. (HS-LS2-4)

*Connection boxes updated as of September 2018*

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Students who demonstrate understanding can:

**HS-LS2-1. Use mathematical and/or computational representations to support explanations of biotic and abiotic factors that affect carrying capacity of ecosystems at different scales.** [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.]

**HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** [Clarification Statement: Examples of mathematical representations could include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]

**HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.** [Clarification Statement: Examples of changes in ecosystem conditions could include ecological succession, modest biological or physical changes, such as moderate hunting or seasonal floods; and extreme changes, such as volcanic eruption or sea level rise.]

**HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.** [Clarification Statement: Examples of human activities could include urbanization, building dams, and dissemination of invasive species. Examples of solutions could include simulations, product development, technological innovations, and/or legislation.]

**HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species’ chances to survive and reproduce.** [Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]

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### Disciplinary Core Ideas

**LS2.A: Interdependent Relationships in Ecosystems**
- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1), (HS-LS2-2)
- (NYSED) Carrying capacity results from the availability of biotic and abiotic factors and from challenges such as predation, competition, and disease. (HS-LS2-1), (HS-LS2-2)

**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**
- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2), (HS-LS2-6)
- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

**LS2.D: Social Interactions and Group Behavior**
- Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)

**LS4.D: Biodiversity and Humans**
- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7)
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7)

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### Crosscutting Concepts

**Cause and Effect**
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-7), (HS-LS2-8)

**Scale, Proportion, and Quantity**
- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)
- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)

**Stability and Change**
- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7)

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### Science and Engineering Practices

**Using Mathematics and Computational Thinking**
- Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
- Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)
- Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)
- Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS2-7)

**Constructing Explanations and Designing Solutions**
- Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
- Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7)

**Engaging in Argument from Evidence**
- Engaging in argument from evidence in 9-12 builds from K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)
- Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-8)

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### Connections to Nature of Science

**Scientific Knowledge is Open to Revision in Light of New Evidence**
- Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2)
- Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an
### New York State P-12 Science Learning Standards

**9-10.RST.8** Assess the extent to which the reasoning and evidence in a source support the author's claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8)

**11-12.RST.1** Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attaining to the precise details of the source, and attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-8)

**11-12.RST.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8)

**11-12.RST.8** Evaluate the data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8)

**9-10.WHST.2** Write informative/explanatory text focused on discipline-specific content. (HS-LS2-1),(HS-LS2-2)

**11-12.WHST.1** Develop possible solutions. (HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-7),(HS-LS2-8)

**11-12.WHST.5** Conduct short as well as more sustained research projects to answer a question (including a self-generated question), analyze a topic, or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS2-7),(HS-LS4-6)

### Mathematics –

**MP.2** Reason abstractly and quantitatively. (HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-7)

**MP.4** Model with Mathematics. (HS-LS2-1),(HS-LS2-2)

**AI-N.Q.1** Select quantities and use units as a way to: i) interpret and guide the solution of multi-step problems; ii) choose and interpret units consistently in formulas; and iii) choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-1),(HS-LS2-2),(HS-LS2-7)

**AI-N.Q.3** Choose a level of accuracy appropriate to limitations on measurement and context when reporting quantities. (HS-LS2-1),(HS-LS2-2),(HS-LS2-7)

**AI-S.ID.1** Represent data with plots on the real number line (dot plots, histograms, and box plots). (HS-LS2-6)

**AI-S.IC.6a** Use the tools of statistics to draw conclusions from numerical summaries. (HS-LS2-6)

**AI-S.IC.6b** Use the language of statistics to critique claims from informational texts. For example, causation vs correlation, bias, measures of center and spread. (HS-LS2-6)

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

#### HS. Inheritance and Variation of Traits

<table>
<thead>
<tr>
<th>Students who demonstrate understanding can:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HS-LS1-4.</strong> Use a model to illustrate cellular division (mitosis) and differentiation.**</td>
</tr>
</tbody>
</table>

**Clarification Statement:** Emphasis should be on the outcomes of mitotic division and cell differentiation on growth and development of complex organisms and possible implications for abnormal cell division (cancer) and stem cell research. [Assessment Boundary: Assessment does not include specific gene control mechanisms or recalling the specific steps of mitosis.]

**HS-LS1-5.** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.** |

**Clarification Statement:** Emphasis should be on the distinction between coding and non-coding regions of DNA.

**HS-LS1-6.** Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, (3) mutations caused by environmental factors and/or (4) genetic engineering.** |

**Clarification Statement:** Emphasis is on using data to support arguments for the way variation occurs including the relevant processes in meiosis and advances in biotechnology. [Assessment Boundary: Assessment does not include recalling the specific details of the phases of meiosis or the biochemical mechanisms of the specific phases in the process.]

**HS-LS1-7.** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.** |

**Clarification Statement:** Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits. [Assessment Boundary: Assessment does not include the details of hormonal regulation or stages of embryonic development.]

**HS-LS1-8.** Use models to illustrate how human reproduction and development maintains continuity of life.** |

**Clarification Statement:** Emphasis is on structures and function of human reproductive systems, interactions with other human body systems, embryonic development, and influences of environmental factors on development. [Assessment Boundary: Assessment does not include the details of hormonal regulation or stages of embryonic development.]

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### Disciplinary Core Ideas

#### LS1.1: Structure and Function

- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (secondary to HS-LS1-1) (Note: Disciplinary Core Idea is also addressed by HS-LS1-3, HS-LS1-4, HS-LS1-8)

- (NYSED) The structures and functions of the human female reproductive system produce gametes in ovariates, allow for internal fertilization, support the internal development of the embryo and fetus in the uterus, and provide essential materials through the placenta, and nutrition through milk for the newborn. The structures and functions of the human male reproductive system produce gametes in testes and make possible the delivery of these gametes for fertilization. (HS-LS1-8)

#### LS1.2: Growth and Development of Organisms

- In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)

- (NYSED) The continuity of life is sustained through reproduction and development. Human development, birth, and aging should be viewed as a predictable pattern of events influenced by factors such as gene expression, hormones, and the environment. (HS-LS1-8)

#### LS1.3: Inheritance of Traits

- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species’ characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet-known function. (HS-LS1-9)

#### LS1.4: Variation of Traits

- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. (HS-LS3-2)

- (NYSED) Environmental factors can cause mutations in genes. Only mutations in sex cells can be inherited. (HS-LS1-8)

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### Crosscutting Concepts

#### Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1, HS-LS1-8)

#### Scale, Proportion, and Quantity

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3)

#### Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—with and between systems at different scales. (HS-LS1-4, HS-LS1-8)

#### Connections to Nature of Science

Science is a Human Endeavor

- Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-2, HS-LS3-3, New NYSED PE)

- Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-2, HS-LS3-3, HS-LS1-8)

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Advances in biotechnology have allowed organisms to be modified genetically. Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.


New York State Next Generation Learning Standards:

**11-12.RST.1** Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attending to the precise details of the source, and attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS3-1), (HS-LS3-2)

**11-12.RST.9** Compare and contrast findings presented in a source to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. (HS-LS3-1)

**9-12.WHST.1** Write arguments focused on discipline-specific content. (HS-LS3-2)

**11-12.SL.5** Make strategic use of digital media and/or visual displays in presentations to enhance understanding of findings, reasoning, and evidence, and to add elements of interest to engage the audience. (HS-LS1-4), (HS-LS1-8)

**Mathematics -**

**MP.2** Reason abstractly and quantitatively. (HS-LS3-2), (HS-LS3-3), (HS-LS1-8)

**MP.4** Model with Mathematics. (HS-LS1-4)

**AI-F.IF.7** Graph functions and show key features of the graph by hand and by using technology where appropriate. (HS-LS1-4)

**AI-F.BF.1** Write a function that describes a relationship between two quantities. (HS-LS1-4)

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

**HS-LS4-1.** Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. (Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and embryological development.)

**HS-LS4-2.** Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. (Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.) [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]

**HS-LS4-3.** Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking that trait. (Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.) [Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.]

**HS-LS4-4.** Construct an explanation based on evidence for how natural selection leads to adaptation of populations. (Clarification Statement: Emphasis is on using data to provide evidence for specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]

**HS-LS4-5.** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. (Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, introduction of invasive species, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.)

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

### Science and Engineering Practices

**Analyzing and Interpreting Data**

Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- **Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.** (HS-LS4-3)

**Constructing Explanations and Designing Solutions**

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- **Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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.** (HS-LS4-2),(HS-LS4-4)

**Engaging in Argument from Evidence**

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.

- **Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.** (HS-LS4-5)

**Obtaining, Evaluating, and Communicating Information**

Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

- **Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).** (HS-LS4-1)

### Disciplinary Core Ideas

**LS4.A: Evidence of Common Ancestry and Diversity**

- **Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps. In fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.** (HS-LS4-1)

**LS4.B: Natural Selection**

- **Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.** (HS-LS4-2),(HS-LS4-3)

- **The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.** (HS-LS4-3)

**LS4.C: Adaptation**

- **Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment’s limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment.** (HS-LS4-2)

- **Natural selection leads to adaptation that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.** (HS-LS4-3),(HS-LS4-4)

- **Adaptation also means that the distribution of traits in a population can change when conditions change.** (HS-LS4-3)

- **Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of other species.** (HS-LS4-4)

### Crosscutting Concepts

**Patterns**

- **Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.** (HS-LS4-1),(HS-LS4-3)

**Causation and Effect**

- **Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.** (HS-LS4-2),(HS-LS4-4),(HS-LS4-5)

### Connections to Nature of Science

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**

- **Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.** (HS-LS4-1),(HS-LS4-4)
**Connections to Nature of Science**

**Science Models, Laws, Mechanisms, and Theories**

- **Explain Natural Phenomena**
  - A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-LS4-1)

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

**Articulation of DCIs across grade-bands:**

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

**ELA/Literacy –**

- 11-12.RST.1 Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attending to the precise details of the source, and attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS4-1), (HS-LS4-2), (LS-HS4-3), (LS-HS4-4)

- 11-12.RST.8 Evaluate the data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS4-5)

- 9-10.WHST.2 Write informative/explanatory text focused on discipline-specific content. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4)

- 11-12.WHST.2 Write explanatory and analytical text focused on discipline-specific content and which uses strategies for conveying information like those used in the respective discipline. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4)

- 11-12.SL.4 Present claims, findings, and supporting evidence, conveying a clear and distinct perspective; alternative or opposing perspectives are addressed; organization, development, substance, and style are appropriate to task, purpose, and audience. (HS-LS4-1), (HS-LS4-2)

**Mathematics –**

- MP.2 Reason abstractly and quantitatively. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4), (HS-LS4-5)

- MP.4 Model with mathematics. (HS-LS4-2)

*Connection boxes updated as of September 2018*

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### Science and Engineering Practices

#### Developing and Using Models
- Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS1-1)

#### Using Mathematical and Computational Thinking
- Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
- Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4)

#### Constructing Explanations and Designing Solutions
- Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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. (HS-ESS1-2),(HS-ESS1-7)

#### Obtaining, Evaluating, and Communicating Information
- Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.
- Communicate scientific ideas (e.g., about phenomena and/or the processes of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-ESS1-3)

### Disciplinary Core Ideas

#### ESS1A: The Universe and Its Stars
- The star called the sun is changing and will burn over a lifespan of approximately 10 billion years. (HS-ESS1-1)
- The family of stars’ light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2),(HS-ESS1-3)
- The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS-ESS1-1)
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2),(HS-ESS1-3)

#### ESS1B: Earth and the Solar System
- Kepler’s laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4)
- (NYSED) Earth and celestial phenomena can be described by principles of relative motion and perspective. (HS-ESS1-7)

#### PS3.D: Energy in Chemical Processes and Everyday Life
- Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (secondary to HS-ESS1-1)
- Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (secondary to HS-ESS1-2)

### Crosscutting Concepts

#### Patterns
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-ESS1-7)
- Scale, Proportion, and Quantity
  - The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1)
  - Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-ESS1-4)

#### Energy and Matter
- Energy cannot be created or destroyed—only moved between one place and another place, between objects and/or fields, or between systems. (HS-ESS1-2)
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-ESS1-3)

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

#### Interdependence of Science, Engineering, and Technology
- Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-2),(HS-ESS1-4)

### Connections to Nature of Science

#### Scientific Knowledge Assumes an

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A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-ESS1-2)

**Order and Consistency in Natural Systems**

- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-ESS1-2)
- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-ESS1-2)

**Connections to other DCIs in the grade-band:**


**Articulation of DCIs across grade-bands:**

- MS.PS1.A (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-4); MS.PS2.A (HS-ESS1-4); MS.PS2.B (HS-ESS1-2); MS.ESS1.A (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-4); MS.ESS1.B (HS-ESS1-4); MS.ESS2.A (HS-ESS1-1); MS.ESS2.D (HS-ESS1-1)

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

**ELA/Literacy –**

- 11-12.RST.1: Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attending to the precise details of the source, and attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS1-1), (HS-ESS1-2)
- 9-10.WHST.2: Write informative/explanatory text focused on discipline-specific content. (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-7)
- 11-12.WHST.2: Write explanatory and analytical text focused on discipline-specific content and which uses strategies for conveying information like those used in the respective discipline. (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-7)
- 11-12.SL.4: Present claims, findings, and supporting evidence, conveying a clear and distinct perspective; alternative or opposing perspectives are addressed; organization, development, substance, and style are appropriate to task, purpose, and audience. (HS-ESS1-3), (HS-ESS1-7)

**Mathematics –**

- MP.2: Reason abstractly and quantitatively. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-4), (HS-ESS1-7)
- MP.4: Model with Mathematics. (HS-ESS1-1), (HS-ESS1-4)
- AI-N.Q.1: Select quantities and use units as a way to: i) interpret and guide the solution of multi-step problems; ii) choose and interpret units consistently in formulas; and iii) choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)
- AI-N.Q.3: Choose a level of accuracy appropriate to limitations on measurement and context when reporting quantities. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)
- AI.SSE.1: Interpret expressions that represent a quantity in terms of its context. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)
- AI.CED.2: Create equations and linear inequalities in two variables to represent a real-world context. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)
- AI.CED.4: Rewrite formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)

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*Connection boxes updated as of September 2018*
### HS. History of the Earth

Students who demonstrate understanding can:

**HS-ESS1-5.** **Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.** [Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages of oceanic crust increasing with distance from mid-ocean ridges as a result of plate spreading and that the North American continental crust contains a much older central ancient core compared to the surrounding continental crust as a result of complex and numerous plate interactions.]

**HS-ESS1-6.** **Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.** [Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's rocks and minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]

**HS-ESS2-1.** **Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.** [Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaux) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive processes (such as volcanism, tectonic uplift, and deposition) and destructive processes (such as weathering, subduction, and coastal erosion.)] [Assessment Boundary: Assessment does not include recalling the details of the formation of specific geographic features of Earth's surface.]

### Science and Engineering Practices

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</tr>
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<td>• Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1)</td>
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<td><strong>Constructing Explanations and Designing Solutions</strong></td>
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</tr>
<tr>
<td>• Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6)</td>
</tr>
<tr>
<td><strong>Engaging in Argument from Evidence</strong></td>
</tr>
<tr>
<td>Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.</td>
</tr>
<tr>
<td>• Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5)</td>
</tr>
</tbody>
</table>

### Disciplinary Core Ideas

#### ESS1.C: The History of Planet Earth
- Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)
- Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as moon rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS1-6)

#### ESS2.A: Earth Materials and Systems
- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1) (Note: This Disciplinary Core Idea is also addressed by HS-ESS2-2)

#### ESS2.B: Plate Tectonics and Large-Scale System Interactions
- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. (ESS2.B Grade 8 GBE) (secondary to HS-ESS1-5),(HS-ESS2-1)
- Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (ESS2.B Grade 8 GBE) (HS-ESS2-1)

#### PSL.C: Nuclear Processes
- (NYSED) Spontaneous radioactive decay follows a characteristic exponential decay law allowing an element's half-life to be used for radiometric dating of rocks and other materials. (secondary to HS-ESS1-5),(secondary to HS-ESS1-6)

**Connections to Nature of Science**

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

- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-ESS1-6)
- Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. (HS-ESS1-6)

**Connections to other DCIs in this grade-band:** HS.PS2.A (HS-ESS1-6); HS.PS2.B (HS-ESS1-6); HS.PS2.C (HS-ESS1-6); HS.PS2.D (HS-ESS1-6)

**Articulation of DCIs across grade-bands:** MS.PS2.B (HS-ESS1-6); MS.LS2.B (HS-ESS1-6); MS.PS3.B (HS-ESS1-6); HS.PS3.A (HS-ESS1-5), (HS-ESS1-6); MS.PS3.A (HS-ESS1-5), (HS-ESS1-6); MS.PS3.B (HS-ESS1-5), (HS-ESS1-6); MS.ESS2.A (HS-ESS1-5), (HS-ESS1-6); MS.ESS2.B (HS-ESS1-5), (HS-ESS1-6); MS.ESS2.C (HS-ESS1-6); MS.ESS2.D (HS-ESS1-6)

### Crosscutting Concepts

<table>
<thead>
<tr>
<th>Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Empirical evidence is needed to identify patterns. (HS-ESS1-5)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stability and Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS1-6)</td>
</tr>
<tr>
<td>• Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS1-6)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>11-12.SL.5</th>
<th>Make strategic use of digital media and/or visual displays in presentations to enhance understanding of findings, reasoning, and evidence, and to add elements of interest to engage the audience. (HS-ESS2-1)</th>
</tr>
</thead>
</table>

**Mathematics –**

**MP.2**
Reason abstractly and quantitatively. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)

**MP.4**
Model with Mathematics. (HS-ESS2-1)

**AI-N.Q.1**
Select quantities and use units as a way to: i) interpret and guide the solution of multi-step problems; ii) choose and interpret units consistently in formulas; and iii) choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)

**AI-N.Q.3**
Choose a level of accuracy appropriate to limitations on measurement and context when reporting quantities. (HS-ESS1-5),(HS-ESS1-5),(HS-ESS2-1)

**AI-F.I.5**
Determine the domain of a function from its graph and, where applicable, identify the appropriate domain for a function in context. (HS-ESS1-6)

**AI-S.ID.6**
Represent bivariate data on a scatter plot, and describe how the variables’ values are related. (HS-ESS1-6)

*Connection boxes updated as of September 2018*

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Arguments may also come from current scientific or historical explanations about the natural and designed world(s). Engaging in Argument from Evidence progresses to using appropriate and sufficient evidence to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

- Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7)

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## Connections to Nature of Science

**Scientific Knowledge is Based on Empirical Evidence**
- The foundation for Earth’s global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space. (HS-ESS2-2)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6)

**ESS2.E: Biogeology**
- The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth’s surface and the life that exists on it. (HS-ESS2-7)

**PS4.A: Wave Properties**
- Scientists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (second to HS-ESS2-3)

### Connections to other DCIs in this grade-band:
- **HS.PS1.A** (HS-ESS2-2),(HS-ESS2-5),(HS-ESS2-6); **HS.PS1.B** (HS-ESS2-5),(HS-ESS2-6); **HS.PS2.B** (HS-ESS2-3); **HS.PS3.B** (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-5); **HS.PS4.B** (HS-ESS2-2); **HS.LS1.C** (HS-ESS2-6); **HS.LS2.A** (HS-ESS2-7); **HS.LS2.B** (HS-ESS2-2),(HS-ESS2-6); **HS.LS2.C** (HS-ESS2-2),(HS-ESS2-7); **HS.LS4.A** (HS-ESS2-7); **HS.LS4.B** (HS-ESS2-7); **HS.LS4.C** (HS-ESS2-2),(HS-ESS2-7); **HS.LS4.D** (HS-ESS2-2),(HS-ESS2-7); **HS.ESS3.C** (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6)
New York State P-12 Science Learning Standards

**HS. Weather and Climate**

Students who demonstrate understanding can:

**HS. ESS2-4.** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.  
[Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition and plate tectonic movement.]  
[Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]

**HS-ESS3-5.** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.  
[Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition.)]  
[Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]

**HS-ESS2-8.** Evaluate data and communicate information to explain how the movement and interactions of air masses result in changes in weather conditions.  
[Clarification Statement: Examples of evidence sources could include station models, surface weather maps, satellite images, radar, and accepted forecast models. Emphasis should focus on communicating how the uneven heating of Earth's surface and prevailing global winds drive the movement of air masses and their corresponding circulation patterns, the interaction of different air masses at frontal boundaries, and resulting weather phenomena.]  
[Assessment Boundary: Analysis is limited to surface weather maps and general weather patterns associated with high and low pressure systems.]

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### Science and Engineering Practices

**Developing and Using Models**
- Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
- Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)

**Analyzing and Interpreting Data**
- Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze evidence.
- Analyze data using tools, technologies and/or models (e.g., computational or mathematical) in order to make valid and reliable scientific claims or determine optimal design solution. (HS-ESS3-5)

**Obtaining, Evaluating, and Communicating Information**
- Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.
- Communicate scientific ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-ESS3-8)

### Disciplinary Core Ideas

#### ESS1.B: Earth and the Solar System
- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes.  
  (secondary to HS-ESS2-4)

#### ESS2.A: Earth Materials and Systems
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)

#### ESS2.D: Weather and Climate
- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-4, secondary to HS-ESS2-2)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-4)
- (NYSED) Concepts of density and heat energy can be used to explain observations of weather patterns (HS-ESS2-8)

#### ESS3.D: Global Climate Change
- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)

### Crosscutting Concepts

#### Patterns
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-ESS2-8)
- Empirical evidence is needed to identify patterns. (HS-ESS2-8)

#### Cause and Effect
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4)

#### Stability and Change
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-5)

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New York State P-12 Science Learning Standards

11-12.SL.5 address a question or solve a problem. (HS-ESS3-3),(HS-ESS2-8)
Make strategic use of digital media and/or visual displays in presentations to enhance understanding of findings, reasoning, and evidence, and to add elements of interest to engage the audience. (HS-ESS2-4)

Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ESS2-4),(HS-ESS3-5),(HS-ESS2-8)
MP.4 Model with Mathematics. (HS-ESS2-4)

AI-N.Q.1 Select quantities and use units as a way to: i) interpret and guide the solution of multi-step problems; ii) choose and interpret units consistently in formulas; and iii) choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-4),(HS-ESS3-5)

AI-N.Q.3 Choose a level of accuracy appropriate to limitations on measurement and context when reporting quantities. (HS-ESS2-4),(HS-ESS3-5),(HS-ESS2-8)

*Connection boxes updated as of September 2018

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Students who demonstrate understanding can:

**HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, management of natural hazards, and changes in climate have influenced human activity. [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting, and soil erosion), and severe weather (such as blizzards, hurricanes, tornadoes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

**HS-ESS3-2.** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]

**HS-ESS3-3.** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning. [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]

**HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoenvironment design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

**HS-ESS3-6.** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.* [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations. [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of computational models.]

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**Science and Engineering Practices**

Using Mathematics and Computational Thinking
Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)
  - Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)

**Constructing Explanations and Designing Solutions**
Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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. (HS-ESS3-1)
- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4)

**Engaging in Argument from Evidence**
Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate forms of evidence— including data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

**Disciplinary Core Ideas**

- **ESS2.D: Weather and Climate**
  - Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HS-ESS3-6)

- **ESS3.A: Natural Resources**
  - Resource availability has guided the development of human society. (HS-ESS3-1)
  - All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

- **ESS3.B: Natural Hazards**
  - Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)

- **ESS3.C: Human Impacts on Earth Systems**
  - The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)
  - Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste that preclude ecosystem degradation. (HS-ESS3-4)

- **ESS3.D: Global Climate Change**
  - Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

- **ETS1.B: Developing Possible Solutions**
  - When evaluating solutions, it is important to take into account the economic, environmental, and societal impacts of technological solutions and energy technologies, and the reliability, affordability, and availability of energy resources. (HS-ESS3-6)

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**Crosscutting Concepts**

- **Cause and Effect**
  - Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1)

- **Systems and System Models**
  - When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6)

- **Stability and Change**
  - Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3)
  - Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4)

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

- **Influence of Engineering, Technology, and Science on Society and the Natural World**
  - Modern civilization depends on major technological systems. (HS-ESS3-1, HS-ESS3-3)
  - Engineers continuously modify these systems to increase benefits while decreasing costs and risks. (HS-ESS3-2, HS-ESS3-4)
  - New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3)
  - Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-2)

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**Connections to Nature of Science**

- **Science is a Human Endeavor**
New York State P-12 Science Learning Standards

| Connections to other DCIs in this grade-band: | **HS.PS1.B** (HS-ESS3-3); **HS.PS3.B** (HS-ESS3-2); **HS.PS3.D** (HS-ESS3-2); **HS.LS2.A** (HS-ESS3-2),(HS-ESS3-3); **HS.LS2.B** (HS-ESS3-2),(HS-ESS3-3); **HS.LS2.C** (HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **HS.LS4.D** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **HS.ESS2.A** (HS-ESS3-2),(HS-ESS3-3); **HS.ESS2.B** (HS-ESS3-3); **HS.ESS2.C** (HS-ESS3-3); **HS.ESS2.D** (HS-ESS3-3); **HS.ESS2.E** (HS-ESS3-3); **HS.ESS3.A** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **HS.ESS3.B** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **HS.ESS3.C** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **HS.ESS3.D** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **HS.ESS3.E** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **HS.ESS3.F** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **HS.ESS3.G** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **HS.ESS3.H** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3) |
| Scientific knowledge is a result of human endeavors, imagination, and creativity. (HS-ESS3-3) |

Science Addresses Questions About the Natural and Material World

- Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2)
- Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2)
- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

| Articulation of DCIs across grade-bands: | **MS.PS1.B** (HS-ESS3-3); **MS.PS3.D** (HS-ESS3-2); **MS.LS2.A** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.LS2.B** (HS-ESS3-2),(HS-ESS3-3); **MS.LS2.C** (HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **MS.LS4.C** (HS-ESS3-3); **MS.LS4.D** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.ESS2.A** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.ESS2.B** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.ESS2.C** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.ESS3.A** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.ESS3.B** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.ESS3.C** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.ESS3.D** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3) |

New York State Next Generation Learning Standards:

| ELA/Literacy - 11-12.RST.1 | Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attending to the precise details of the source, and attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-4) |
| 11-12.RST.8 | Evaluate the data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS3-2),(HS-ESS3-4) |
| 9-10.WHST.2 | Write informative/explanatory text focused on discipline-specific content. (HS-ESS3-1) |
| 11-12.WHST.2 | Write explanatory and analytical text focused on discipline-specific content and which uses strategies for conveying information like those used in the respective discipline. (HS-ESS3-1) |

Mathematics -

| **MP.2** | Reason abstractly and quantitatively. (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6) |
| **MP.4** | Model with Mathematics. (HS-ESS3-3),(HS-ESS3-6) |
| **AI-N.Q.1** | Select quantities and use units as a way to: i) interpret and guide the solution of multi-step problems; ii) choose and interpret units consistently in formulas; and iii) choose and interpret the scale and the origin in graphs and data displays. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-6) |
| **AI-N.Q.3** | Choose a level of accuracy appropriate to limitations on measurement and context when reporting quantities. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-6) |

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**Science and Engineering Practices**

**Asking Questions and Defining Problems**

- Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
  - Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

**Using Mathematics and Computational Thinking**

- Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
  - Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)

**Constructing Explanations and Designing Solutions**

- Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.
  - Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)
  - Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)

**Disciplinary Core Ideas**

**ETS1.A: Defining and Delimiting Engineering Problems**

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-3)

**ETS1.B: Developing Possible Solutions**

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)
- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)

**ETS1.C: Optimizing the Design Solution**

- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)

**Crosscutting Concepts**

**Systems and System Models**

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—in and between systems at different scales. (HS-ETS1-4)

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

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)

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

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)

**Connections to HS-ETS1.A: Defining and Delimiting Engineering Problems include:**

- **Physical Science:** HS-PS2-3, HS-PS3-3

**Connections to HS-ETS1.B: Designing Solutions to Engineering Problems include:**

- **Earth and Space Science:** HS-ESS3-2, HS-ESS3-4
- **Life Science:** HS-LS2-7, HS-LS4-6

**Connections to HS-ETS1.C: Optimizing the Design Solution include:**

- **Physical Science:** HS-PS1-6, HS-PS2-3

**Articulation of DOK’s across grade-bands:**

- **MS.ETS1.A (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4); MS.ETS1.B (HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4); MS.ETS1.C (HS-ETS1-2),(HS-ETS1-4)**

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

- **ELA/Literacy:**
  - 11-12.RST.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1),(HS-ETS1-3)

- **11-12.RST.8:** Evaluate the data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

- **11-12.RST.9:** Compare and contrast findings presented in a source to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. (HS-ETS1-1),(HS-ETS1-3)

- **Mathematics –**
  - **MP.2:** Reason abstractly and quantitatively. (HS-EST1-1),(HS-ETS1-3),(HS-ETS1-4)
  - **MP.4:** Model with Mathematics. (HS-EST1-2),(HS-ETS1-3),(HS-ETS1-4)

*Connection boxes updated as of September 2018*