Performance Expectations at a Glance

In this unit, students will discover and practice the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts needed to perform the following Performance Expectations.

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<th>Module: Mechanical Energy</th>
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<td>MS-ETS1-4</td>
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Correlations by Module to the NGSS

**MODULE: Forces and Motion**

<table>
<thead>
<tr>
<th>MS-PS2</th>
<th>Motion and Stability: Forces and Interactions</th>
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<tbody>
<tr>
<td>MS-PS2-1</td>
<td>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.]</td>
</tr>
</tbody>
</table>

Labs and investigations are in italics.
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.

• Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1)

* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.

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). (MS-PS2-1)

Crosscutting Concepts

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)

* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.

Connections to Engineering, Technology, and Applications 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)

Correlations

Labs and investigations are in italics.
Labs and investigations are in italics.

<table>
<thead>
<tr>
<th>MS-PS2</th>
<th>Motion and Stability: Forces and Interactions</th>
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<tbody>
<tr>
<td>MS-PS2.2.</td>
<td>Plan 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, 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 one dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]</td>
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<td>40, 40–42</td>
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</tbody>
</table>

**SEP Science and Engineering Practices**

**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)

|        | 15–17, 40, 41–42, 95–102, 103 |

**Connections to Nature of Science**

**Scientific Knowledge is Based on Empirical Evidence**
• Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS2-2)

|        | 23, 40, 47, 81–82, 85 |

**DCI Disciplinary Core Ideas**

**PS2.A: Forces and Motion**
• 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)

|        | 10–11, 11–12, 12, 13–14, 14, 15–17, 18, 20–21, 25, 26, 40 |
Continued from previous page.

### Disciplinary Core Ideas

**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. (MS-ETS1-3)
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)

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

### CCSS ELA/Literacy Connections

| ELA RST.6–8.1 | 8–9, 36–37, 60–61, 78–79, 85, 95–102, Literacy Skill Handbook (online) |
| ELA RST.6–8.7 | 81–82, 95–102, Literacy Skill Handbook (online) |
| ELA RST.6–8.9 | 46, 95–102, Literacy Skill Handbook (online) |

### CCSS Math Connections

| Math 7.EE.B.3 | 32, 38–41, 44, 89, Math Skill Handbook (online) |

### MS-PS2

**Motion and Stability: Forces and Interactions**

**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.

### SEP 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 generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)

* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.

Labs and investigations are in italics.
Crosscutting Concepts

Stability and Change
• Explanations 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)

7, 20–21, 22–23, 25, 27–28, 29, 30–32, 40, 41–42, 52, 83–84, 90, 95–102, Lab Calculate Average Speed from a Graph (online)

CCSS ELA/Literacy Connections

ELA RST.6–8.3

ELA WHST.6–8.7
24, 53, 71, 91, 95–102, Literacy Skill Handbook (online)

CCSS Math Connections

Math MP.2

Math 6.EE.A.2
22–23, 44, 89, Math Skill Handbook (online)

Math 7.EE.B.3–4
32, 38–41, 44, 89, Math Skill Handbook (online)

MS-PS2 Motion and Stability: Forces and Interactions

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. [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.]

85, 90, 92

SEP Science and Engineering Practices

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)

30, 43, 67, 90, 92, 95–102

Labs and investigations are in italics.
Continued from previous page.

### Connections to Nature of Science

**Scientific Knowledge is Based on Empirical Evidence**
- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS2-4)  

<table>
<thead>
<tr>
<th>DCI</th>
<th>Disciplinary Core Ideas</th>
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<tbody>
<tr>
<td><strong>PS2.B: Types of Interactions</strong></td>
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<tr>
<td>• 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)</td>
<td>23, 40, 47, 81–82, 85</td>
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<tr>
<th>CCC</th>
<th>Crosscutting Concepts</th>
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<tr>
<td><strong>Systems and System Models</strong></td>
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</tr>
<tr>
<td>• Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-4)</td>
<td>81–82, 82, 83–84, 84–86, 90, 90, 92–94, 95–102</td>
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<tr>
<th>SEP</th>
<th>Science and Engineering Practices</th>
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<tr>
<td><strong>Asking Questions and Defining Problems</strong></td>
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<tr>
<td>Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)</td>
<td>95–102</td>
</tr>
</tbody>
</table>

* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.

Labs and investigations are in italics.
Continued from previous page.

### DCI Disciplinary Core Ideas

**ETS1.A: Defining and Delimiting Engineering Problems**

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

| 95–102, Science and Engineering Practices Handbook (online) |

### CCC Crosscutting Concepts

**Connections to Science, Technology, Society and the Environment**

**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-ETS1-1)

- The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

| 95–102 |

### CCSS ELA/Literacy Connections

**ELA RST.6–8.1**

- 8–9, 36–37, 60–61, 78–79, 85, 95–102, Literacy Skill Handbook (online)

**ELA WHST.6–8.8**

- 95–102, Literacy Skill Handbook (online)

### CCSS Math Connections

**Math MP.2**


**Math 7.EE.B.3**

- 32, 38–41, 44, 89, Math Skill Handbook (online)

### MS-ETS1 Engineering Design

**MS-ETS1-2.**

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

| 95–102 |

### SEP Science and Engineering Practices

**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.

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

| 95–102 |

Labs and investigations are in italics.
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<table>
<thead>
<tr>
<th>Disciplinary Core Ideas</th>
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<tr>
<td><strong>ETS1.B: Developing Possible Solutions</strong></td>
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<tr>
<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) possible solutions. (MS-ETS1-1)</td>
<td>65–66, 95–102, Science and Engineering Practices Handbook (online)</td>
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<tr>
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<tr>
<td><strong>ELA RST.6–8.1</strong></td>
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<td><strong>ELA WHST.6–8.7</strong></td>
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<td><strong>ELA WHST.6–8.9</strong></td>
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<td><strong>Math 7.EE.B.3</strong></td>
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<td><strong>Analyzing and Interpreting Data</strong></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>10–11, 80–81, 95–102</td>
</tr>
<tr>
<td>• Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)</td>
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<tr>
<td>* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.</td>
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* Labs and investigations are in italics.
Disciplinary Core Ideas

**ETS1.B: Developing Possible Solutions**
- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)
- Models of all kinds are important for testing solutions. (MS-ETS1-4)
  
**ETS1.C: Optimizing the Design Solution**
- 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)

**CCSS ELA/Literacy Connections**
- ELA SL.8.5
  - 53, 71, Literacy Skill Handbook (online)

**CCSS Math Connections**
- Math MP.2
- Math 7.SP.C.7
  - Math Skill Handbook (online)

**ALSO INTEGRATES:**
- SEP Asking Questions and Defining Problems
  - 3, 24, 65–66, 95–102, 103
- SEP Developing and Using Models
- SEP Analyzing and Interpreting Data
- SEP Using Mathematics and Computational Thinking
- SEP Constructing Explanations and Designing Solutions
- SEP Obtaining, Evaluating, and Communicating Information
  - 10–11, 13–14, 24, 85, 95–102
- Connections to Nature of Science Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
  - 44, 47, 51, 64, 83–84, 85
- DCI ESS1.A: The Universe and Its Stars
  - 86
- DCI ESS1.B: Earth and the Solar System
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<tr>
<td>Connections to Nature of Science Science is a Way of Knowing</td>
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<td>Connections to Nature of Science Science is a Human Endeavor</td>
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<td>Connections to Nature of Science Science Addresses Questions About the Natural and Material World</td>
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<td>CCSS ELA RST.6–8.10</td>
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<td>CCSS ELA WHST.6–8.4</td>
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<td>CCSS ELA WHST.6–8.6</td>
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<td>CCSS ELA SL.8.1</td>
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<td>CCSS Math 6.RP.A.1</td>
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<td>CCSS Math 6.RP.A.3</td>
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<tr>
<td>CCSS Math 6.RP.A.2</td>
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Labs and investigations are in italics.
## MODULE: Mechanical Energy

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<td>MS-PS3-1</td>
<td><strong>Construct and interpret graphical displays of data to describe</strong></td>
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<td><strong>the relationships of kinetic energy to the mass of an object and</strong></td>
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<td><strong>to the speed of an object. [Clarification Statement: Emphasis is</strong></td>
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<td><strong>on descriptive relationships between kinetic energy and mass</strong></td>
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<td><strong>separately from kinetic energy and speed. Examples could include</strong></td>
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<td><strong>riding a bicycle at different speeds, rolling different sizes of</strong></td>
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<td><strong>rocks downhill, and getting hit by a wiffle ball versus a tennis</strong></td>
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<td><strong>ball.]</strong></td>
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### SEP Science and Engineering Practices

**Analyzing and Interpreting Data**

Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)

* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.

### DCI Disciplinary Core Ideas

**PS3.A: Definitions of Energy**

- Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)

**CCC Crosscutting Concepts**

**Scale, Proportion, and Quantity**

- Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1)

### CCSS ELA/Literacy Connections

- **ELA RST.6–8.1**

- **ELA RST.6–8.7**
  - 146–148, 151–152, 153, Literacy Skill Handbook (online)

### CCSS Math Connections

- **Math MP.2**

- **Math 6.RP.A.1**
  - 116, Math Skill Handbook (online)

- **Math 6.RP.A.2**
  - 117, Math Skill Handbook (online)

- **Math 7.RP.A.2**

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

[Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]

### MS-PS3 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 cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate’s hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.]

[Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]

### SEP 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 unobservable mechanisms. (MS-PS3-2)

### DCI Disciplinary Core Ideas

**PS3.A: Definitions of Energy**

- A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)

**PS3.C: Relationship Between Energy and Forces**

- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)

### CCC Crosscutting Concepts

**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-PS3-2)

### CCSS ELA/Literacy Connections

**ELA SL.8.5**

121, 137, 157, 161–166

*Labs and investigations are in italics.*

Correlations xxiii
### MS-PS3 Energy

**MS-PS3-5.** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [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 does not include calculations of energy.]

160, 161–166

### SEP Science and Engineering Practices

**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 worlds.

- Construct, use, 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. (MS-PS3-5)

117–119, 150, 160, 161–166

### Connections to Nature of Science

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


### DCI Disciplinary Core Ideas

**PS3.B: Conservation of Energy and Energy Transfer**
- When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)


### CCC Crosscutting Concepts

**Energy and Matter**
- Energy may take different forms (e.g., energy in fields, thermal energy, energy of motion). (MS-PS3-5)


* = Other aspects of this CCC are integrated throughout this module and are listed in the Also Integrates section.

### CCSS ELA/Literacy Connections

**ELA RST.6–8.1**


**ELA WHST.6–8.1**

117–119, 150, 160, 161–166, Literacy Skill Handbook (online)

### CCSS Math Connections

**Math MP.2**

113–115, 117–119, Math Skill Handbook (online)

* Labs and investigations are in italics.
MS-ETS1 Engineering Design

| 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. | 261–266 |

**SEP 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, clarifying arguments and models.
- Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)

* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.

**DCI Disciplinary Core Ideas**

**ETS1.A: Defining and Delimiting Engineering Problems**

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

**CCC Crosscutting Concepts**

**Connections to Science, Technology, Society and the Environment**

- 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-ETS1-1)
  
- The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

**CCSS ELA/Literacy Connections**

- ELA RST.6–8.1
  
- ELA WHST.6–8.8

**CCSS Math Connections**

- Math MP.2
  
- Math 7.EE.B.3

Labs and investigations are in italics.
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<table>
<thead>
<tr>
<th>Math 6.RP.A.1</th>
<th>116, Math Skill Handbook (online)</th>
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</table>

**ALSO INTERGRATES:**

| SEP Asking Questions and Defining Problems | 167 |
| SEP Planning and Carrying Out Investigations | 109, 112, 127, 133–135, 167 |
| SEP Analyzing and Interpreting Data | 109, 133–135 |
| SEP Obtaining, Evaluating, and Communicating Information | 121, 137, 156 |
| CCC Patterns | 113–115, 117–119, 133–135, 150 |
| CCC Cause and Effect | 133–135 |
| CCC Energy and Matter | 120, 150, 151–152 |
| Connections to Nature of Science  Scientific is a Human Endeavor | 137 |
| CCSS ELA SL.8.4 | 161–166 |
| CCSS ELA SL.8.5 | 121, 137, 157, 161–166 |
| CCSS ELA RST.6–8.10 | 156 |
| CCSS ELA WHST.6–8.4 | 161–166 |
| CCSS ELA WHST.6–8.10 | 161–166 |
| CCSS Math MP.4 | 113–115, 117–119, 120 |

Labs and investigations are in italics.
MODULE: Electromagnetic Forces

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

177, 209, 235

**SEP Science and Engineering Practices**

**Asking Questions and Defining Problems***

Asking questions and defining problems in grades 6–8 builds from 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)

* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.

177, 209, 235, 267

**DCI Disciplinary Core Ideas**

**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)


**CCC Crosscutting Concepts**

**Cause and Effect**

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3)


**CCSS ELA/Literacy Connections**

**ELA RST.6–8.1**

174–175, 185, 200–201, 220–221, 236–237, Literacy Skill Handbook (online)

**CCSS Math Connections**

**Math MP.2**


Labs and investigations are in italics.
MS-PS2 Motion and Stability: Forces and Interactions

**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.] [Assessment Boundary: Assessment is limited to electric and magnetic fields, and is limited to qualitative evidence for the existence of fields.]

182–183, 202–203, 205–207, 261–266

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**SEP Science and Engineering Practices**

**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.

- 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)

* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.


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**DCI Disciplinary Core Ideas**

**PS2.B: Types of Interactions**

- 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)


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**CCC Crosscutting Concepts**

**Cause and Effect**

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-5)


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**CCSS ELA/Literacy Connections**

**ELA RST.6–8.3**


**ELA WHST.6–8.7**

193, 213, 229, 257, Literacy Skill Handbook (online)

Labs and investigations are in italics.
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<table>
<thead>
<tr>
<th>MS-PS3</th>
<th>Energy</th>
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<tbody>
<tr>
<td>MS-PS3-2.</td>
<td><strong>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.</strong> [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate’s hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]</td>
</tr>
<tr>
<td>189, 214, 261–266</td>
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</table>

**SEP  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 unobservable mechanisms. (MS-PS3-2)

* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.

182–183, 184, 189, 192, 205–207, 222–223, 230, 242, 258, 261–266, PhET Interactive Simulation Magnet and Compass (online)

**DCI  Disciplinary Core Ideas**

**PS3.A: Definitions of Energy**
- A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)


**PS3.C: Relationship Between Energy and Forces**
- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)

187–188, 188–189, 194–195, 210, 261–266

**CCC  Crosscutting Concepts**

**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-PS3-2)

189, 195, 205–207, 214, 222–223, 230, 258, 261–266

**CCSS ELA/Literacy Connections**

| ELA SL.8.5 | 213, 229, 257, Literacy Skill Handbook (online) |

Labs and investigations are in italics.
### MS-ETS1 Engineering Design

| **MS-ETS1-2.** | Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. | 261–266 |

#### SEP Science and Engineering Practices

**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.

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

* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.

#### DCI Disciplinary Core Ideas

**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. (MS-ETS1-2) possible solutions. (MS-ETS1-1)

#### CCSS ELA/Literacy Connections

| **ELA RST.6–8.1** | 174–175, 185, 200–201, 220–221, 236–237, Literacy Skill Handbook (online) |
| **ELA RST.6–8.9** | Literacy Skill Handbook (online) |
| **ELA WHST.6–8.7** | 193, 213, 229, 257, Literacy Skill Handbook (online) |
| **ELA WHST.6–8.9** | Literacy Skill Handbook (online) |

#### CCSS Math Connections

| **Math 7.EE.B.3** | 261–266, Math Skill Handbook (online) |

### MS-ETS1 Engineering Design

| **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. | 261–266 |

Labs and investigations are in italics.

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** xxx Correlations
**SEP  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-ETS1-3)

* Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.

**DCI  Disciplinary Core Ideas**

**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. (MS-ETS1-3)

- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)

**ETS1.C: Optimizing the Design Solution**

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

**CCSS ELA/Literacy Connections**

- ELA RST.6–8.1

- ELA RST.6–8.7

- ELA RST.6–8.9

**CCSS Math Connections**

- Math MP.2

- Math 7.EE.B.3

**MS-ETS1  Engineering Design**

- 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.

Labs and investigations are in italics.

Correlations  xxxi
Continued from previous page.

### SEP  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 generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)

*Other aspects of this SEP are integrated throughout this module and are listed in the Also Integrates section.*

### DCI  Disciplinary Core Ideas

**ETS1.B: Developing Possible Solutions**

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

- Models of all kinds are important for testing solutions. (MS-ETS1-4)

- 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)

**ETS1.C: Optimizing the Design Solution**

- 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)

### CCSS ELA/Literacy Connections

- ELA SL.8.5

### CCSS Math Connections

- Math MP.2

- Math 7.SP.7

### ALSO INTEGRATES:

- SEP Asking Questions and Defining Problems
- SEP Developing and Using Models
- SEP Planning and Carrying Out Investigations

Labs and investigations are in italics.
| SEP | Analyzing and Interpreting Data | 177, 243–245, 259, 261–266 |
| SEP | Engaging in Argument from Evidence | 204, 227, 260, 261–266 |
| SEP | Obtaining, Evaluating, and Communicating Information | 185 |
| CCC | Patterns | 222–223 |
| CCC | Energy and Matter | 187–188, 188–189 |
| CCC | Structure and Function | 243–245, 261–266 |
| CCSS ELA | RST.6–8.10 | 185, 193, 213, 229, 257 |
| CCSS ELA | WHST.6–8.1 | 260 |
| CCSS ELA | WHST.6–8.4 | 193, 229 |
| CCSS ELA | WHST.6–8.6 | 193, 213, 229, 257 |
| CCSS ELA | WHST.6–8.10 | 193, 260 |
| CCSS ELA | SL.8.1 | 185 |
| CCSS ELA | SL.8.4 | 213, 257 |
| CCSS Math | MP.4 | 208–209, PhET Ohm’s Law (online) |
| CCSS Math | 6.EE.A.2 | PhET Ohm’s Law (online) |
| CCSS Math | 6.NS.C.5 | 208–209, 231, PhET Ohm’s Law (online) |
| CCSS Math | 6.RP.A.1 | 243–245 |
| CCSS Math | 6.RP.A.3 | 243–245 |
| CCSS Math | 6.RP.B.5 | 208–209 |
| CCSS Math | 7.RP.A.2 | 208–209, 225–226, PhET Ohm’s Law (online) |
| CCSS Math | 7.EE.B.4 | PhET Ohm’s Law (online) |
| CCSS Math | 8.EE.A.2 | 208–209 |