

Grade 6 Science

Scope and Sequence

Unit of Study 1: Growth and Development of Organisms

Standards that appear this unit: MS-LS1-4, MS-LS1-5

MS. Growth, Development, and Reproduction of Organisms		
Students who demonstrate understanding can:		
<p>MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]</p>		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Engaging in Argument from Evidence</p> <p>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).</p> <ul style="list-style-type: none"> Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS1-4) 	<p>LS1.B: Growth and Development of Organisms</p> <ul style="list-style-type: none"> Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4) Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4) 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS1-4)
<i>Connections to other DCIs in this grade-band:</i> MS.LS2.A (MS-LS1-4)		
<i>Articulation to DCIs across grade-bands:</i> 3.LS1.B (MS-LS1-4); HS.LS2.A (MS-LS1-4); HS.LS2.D (MS-LS1-4)		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-4)	
RI.6.8	Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (MS-LS1-4)	
WHST.6-8.1	Write arguments focused on discipline content. (MS-LS1-4)	
<i>Mathematics –</i>		
6.SP.A.2	Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (MS-LS1-4)	
6.SP.B.4	Summarize numerical data sets in relation to their context. (MS-LS1-4)	

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MS. Growth, Development, and Reproduction of Organisms		
Students who demonstrate understanding can:		
MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. <ul style="list-style-type: none"> ▪ Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-5) 	LS1.B: Growth and Development of Organisms <ul style="list-style-type: none"> ▪ Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5) 	Cause and Effect <ul style="list-style-type: none"> ▪ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS1-5)
<i>Connections to other DCIs in this grade-band: MS.LS2.A (MS-LS1-5);</i>		
<i>Articulation to DCIs across grade-bands: 3.LS1.B (MS-LS1-5); 3.LS3.A (MS-LS1-5); HS.LS2.A (MS-LS1-5)</i>		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-5)	
RST.6-8.2	Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-LS1-5)	
WHST.6-8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS1-5)	
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-5)	
<i>Mathematics –</i>		
6.SP.A.2	Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (MS-LS1-5)	
6.SP.B.4	Summarize numerical data sets in relation to their context. (MS-LS1-5)	

Unit of Study 2: Ecosystems

Standards that appear this unit: MS-LS2-1, MS-LS2-2, MS-LS2-3

MS. Matter and Energy in Organisms and Ecosystems		
Students who demonstrate understanding can:		
<p>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.]</p>		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<p style="text-align: center;">Science and Engineering Practices</p> <p>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.</p> <ul style="list-style-type: none"> Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)
<p><i>Connections to other DCIs in this grade-band:</i> MS.ESS3.A (MS-LS2-1); MS.ESS3.C (MS-LS2-1)</p>		
<p><i>Articulation across grade-bands:</i> 3.LS2.C (MS-LS2-1); 3.LS4.D (MS-LS2-1); 5.LS2.A (MS-LS2-1); HS.LS2.A (MS-LS2-1); HS.LS4.C (MS-LS2-1); HS.LS4.D (MS-LS2-1); HS.ESS3.A (MS-LS2-1)</p>		
<p><i>Common Core State Standards Connections:</i></p> <p><i>ELA/Literacy –</i></p> <p>RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-1)</p> <p>RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS2-1)</p>		

MS. Interdependent Relationships in Ecosystems		
Students who demonstrate understanding can:		
MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. <ul style="list-style-type: none"> Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2) 	LS2.A: Interdependent Relationships in Ecosystems <ul style="list-style-type: none"> 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) 	Patterns <ul style="list-style-type: none"> Patterns can be used to identify cause and effect relationships. (MS-LS2-2)
<i>Connections to other DCIs in this grade-band:</i> MS.LS1.B (MS-LS2-2)		
<i>Articulation across grade-band:</i> 1.LS1.B (MS-LS2-2); HS.LS2.A (MS-LS2-2); HS.LS2.B (MS-LS2-2); HS.LS2.D (MS-LS2-2)		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-2)	
WHST.6-8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS2-2)	
WHST.6-8.9	Draw evidence from literary or informational texts to support analysis, reflection, and research. (MS-LS2-2)	
SL.8.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS2-2)	
SL.8.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS2-2)	
<i>Mathematics –</i>		
6.SP.B.5	Summarize numerical data sets in relation to their context. (MS-LS2-2)	

MS. Matter and Energy in Organisms and Ecosystems		
Students who demonstrate understanding can:		
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 into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]		
The performance expectations above were developed using the following elements from the NRC document: <i>A Framework for K-12 Science Education</i> :		
<p style="text-align: center;">Science and Engineering Practices</p> <p>Developing and Using Models</p> <p>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.</p> <ul style="list-style-type: none"> Develop a model to describe phenomena. (MS-LS2-3) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>LS2.B: Cycle of Matter and Energy Transfer in Ecosystems</p> <ul style="list-style-type: none"> Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Energy and Matter</p> <ul style="list-style-type: none"> The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3) <p style="text-align: center;">-----</p> <p style="text-align: center;">Connections to Nature of Science</p> <p>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</p> <ul style="list-style-type: none"> Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3)
Connections to other DCIs in this grade-band: MS.PS1.B (MS-LS2-3); MS.ESS2.A (MS-LS2-3)		
Articulation across grade-bands: 5.LS2.A (MS-LS2-3); 5.LS2.B (MS-LS2-3); HS.PS3.B (MS-LS2-3); HS.LS1.C (MS-LS2-3); HS.LS2.B (MS-LS2-3); HS.ESS2.A (MS-LS2-3)		
Common Core State Standards Connections:		
<p><i>ELA/Literacy</i> –</p> <p>SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS2-3)</p> <p><i>Mathematics</i> –</p> <p>6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (MS-LS2-3)</p>		

Unit of Study 3: Ecosystem Dynamics Functioning and Resilience

Standards that appear this unit: MS-LS2-4, MS-LS2-5 *, MS-ETS1.1, MS-ETS1.3

MS. Matter and Energy in Organisms and Ecosystems		
Students who demonstrate understanding can:		
<p>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 changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]</p>		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<p>Science and Engineering Practices</p> <p>Engaging in Argument from Evidence</p> <p>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).</p> <ul style="list-style-type: none"> 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) <p>-----</p> <p>Connections to Nature of Science</p> <p>Scientific Knowledge is Based on Empirical Evidence</p> <p>Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4)</p>	<p>Disciplinary Core Ideas</p> <p>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</p> <ul style="list-style-type: none"> 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) 	<p>Crosscutting Concepts</p> <p>Stability and Change</p> <ul style="list-style-type: none"> Small changes in one part of a system might cause large changes in another part. (MS-LS2-4)
<p><i>Connections to other DCIs in this grade-band:</i> MS.LS4.C (MS-LS2-4); MS.LS4.D (MS-LS2-4); MS.ESS2.A (MS-LS2-4); MS.ESS3.A (MS-LS2-4); MS.ESS3.C (MS-LS2-4)</p>		
<p><i>Articulation across grade-bands:</i> 3.LS2.C (MS-LS2-4); 3.LS4.D (MS-LS2-4); HS.LS2.C (MS-LS2-4); HS.LS4.C (MS-LS2-4); HS.LS4.D (MS-LS2-4); HS.ESS2.E (MS-LS2-4); HS.ESS3.B (MS-LS2-4); HS.ESS3.C (MS-LS2-4)</p>		
<p><i>Common Core State Standards Connections:</i></p> <p><i>ELA/Literacy –</i></p> <p>RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-4)</p> <p>RI.8.8 Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (MS-LS2-4)</p> <p>WHST.6-8.1 Write arguments to support claims with clear reasons and relevant evidence. (MS-LS2-4)</p> <p>WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS2-4)</p>		

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MS. Interdependent Relationships in Ecosystems		
Students who demonstrate understanding can:		
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services. * [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. 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 <i>A Framework for K-12 Science Education</i> :		
<p style="text-align: center;">Science and Engineering Practices</p> <p>Engaging in Argument from Evidence</p> <p>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).</p> <ul style="list-style-type: none"> Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</p> <ul style="list-style-type: none"> Biodiversity describes the variety of species found in Earth’s terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem’s biodiversity is often used as a measure of its health. (MS-LS2-5) <p>LS4.D: Biodiversity and Humans</p> <ul style="list-style-type: none"> 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) <p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none"> 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) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Stability and Change</p> <ul style="list-style-type: none"> Small changes in one part of a system might cause large changes in another part. (MS-LS2-5) <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;">Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> 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) <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;">Connections to Nature of Science</p> <p>Science Addresses Questions About the Natural and Material World</p> <ul style="list-style-type: none"> Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)
<i>Connections to other DCIs in this grade-band: MS.ESS3.C (MS-LS2-5)</i>		
<i>Articulation across grade-band: HS.LS2.A (MS-LS2-5); HS.LS2.C (MS-LS2-5); HS.LS4.D (MS-LS2-5); HS.ESS3.A (MS-LS2-5); HS.ESS3.C (MS-LS2-5); HS.ESS3.D (MS-LS2-5)</i>		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
RST.6-8.8	Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (MS-LS2-5)	
RI.8.8	Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (MS-LS2-5)	
<i>Mathematics –</i>		
MP.4	Model with mathematics. (MS-LS2-5)	
6.RP.A.3	Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-LS2-5)	

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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.		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. <ul style="list-style-type: none"> 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) 	ETS1.A: Defining and Delimiting Engineering Problems <ul style="list-style-type: none"> 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) 	Influence of Science, Engineering, and Technology on Society and the Natural World <ul style="list-style-type: none"> 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)
<i>Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include: Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include:</i> Physical Science: MS-PS3-3 <i>Connections to MS-ETS1.B: Developing Possible Solutions Problems include:</i> Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5 <i>Connections to MS-ETS1.C: Optimizing the Design Solution include:</i> Physical Science: MS-PS1-6		
<i>Articulation of DCIs across grade-bands: 3-5.ETS1.A (MS-ETS1-1); 3-5.ETS1.C (MS-ETS1-1); HS.ETS1.A (MS-ETS1-1); HS.ETS1.B (MS-ETS1-1)</i>		
<i>Common Core State Standards Connections:</i> ELA/Literacy – RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1) WHST.6-8.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ETS1-1) Mathematics – MP.2 Reason abstractly and quantitatively. (MS-ETS1-1) 7.EE.3 Solve multi-step real-life 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; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1)		

MS. Engineering Design		
Students who demonstrate understanding can: 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 <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. <ul style="list-style-type: none"> Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4) 	ETS1.B: Developing Possible Solutions <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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) 	N/A
<i>Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include:</i> Physical Science: MS-PS3-3 <i>Connections to MS-ETS1.B: Developing Possible Solutions Problems include:</i> Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5 <i>Connections to MS-ETS1.C: Optimizing the Design Solution include:</i> Physical Science: MS-PS1-6		
<i>Articulation of DCIs across grade-bands: 3-5.ETS1.B (MS-ETS1-4); 3-5.ETS1.C (MS-ETS1-4); HS.ETS1.B (MS-ETS1-4); HS.ETS1.C (MS-ETS1-4)</i>		
<i>Common Core State Standards Connections:</i> ELA/Literacy – SL.8.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ETS1-4) Mathematics – MP.2 Reason abstractly and quantitatively. (MS-ETS1-4) 7.SP Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. (MS-ETS1-4)		

Unit of Study 4: Forces and Motion

Standards that appear this unit: MS-PS2-1*, MS-ETS1-2, MS-PS2-2, MS-ETS1-3, MS-ETS1-1 MS-ETS1-4

MS. Forces and Interactions		
Students who demonstrate understanding can:		
<p>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.]</p>		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<p style="text-align: center;">Science and Engineering Practices</p> <p>Constructing Explanations and Designing Solutions</p> <p>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.</p> <ul style="list-style-type: none"> Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>PS2.A: Forces and Motion</p> <ul style="list-style-type: none"> 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) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Systems and System Models</p> <p>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)</p> <p style="text-align: center;">-----</p> <p>Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> 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)
<i>Connections to other DCIs in this grade-band: MS.PS3.C (MS-PS2-1)</i>		
<i>Articulation across grade-bands: 3.PS2.A (MS-PS2-1); HS.PS2.A (MS-PS2-1)</i>		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (MS-PS2-1)	
RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS2-1)	
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS2-1)	
<i>Mathematics –</i>		
MP.2	Reason abstractly and quantitatively. (MS-PS2-1)	
6.NS.C.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)	
6.EE.A.2	Write, read, and evaluate expressions in which letters stand for numbers. (MS-PS2-1)	
7.EE.B.3	Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form, using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-PS2-1)	
7.EE.B.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)	

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MS. Forces and Interactions		
Students who demonstrate understanding can:		
MS-PS2-2. 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.]		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<p style="text-align: center;">Science and Engineering Practices</p> <p>Planning and Carrying Out Investigations</p> <p>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.</p> <ul style="list-style-type: none"> 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) <p style="text-align: center;">-----</p> <p style="text-align: center;">Connections to Nature of Science</p> <p>Scientific Knowledge is Based on Empirical Evidence</p> <ul style="list-style-type: none"> Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS2-2) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>PS2.A: Forces and Motion</p> <ul style="list-style-type: none"> 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) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Stability and Change</p> <ul style="list-style-type: none"> 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)
<i>Connections to other DCIs in this grade-band:</i> MS.PS3.A (MS-PS2-2); MS.PS3.B (MS-PS2-2); MS.ESS2.C (MS-PS2-2)		
<i>Articulation across grade-bands:</i> 3.PS2.A (MS-PS2-2); 5HS.PS2.A (MS-PS2-2); HS.PS3.B (MS-PS2-2); HS.ESS1.B (MS-PS2-2)		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS2-2)	
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS2-2)	
<i>Mathematics –</i>		
MP.2	Reason abstractly and quantitatively. (MS-PS2-2)	
6.EE.A.2	Write, read, and evaluate expressions in which letters stand for numbers. (MS-PS2-2)	
7.EE.B.3	Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form, using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-PS2-2)	
7.EE.B.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-PS2-2)	

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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.		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. <ul style="list-style-type: none"> 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) 	ETS1.A: Defining and Delimiting Engineering Problems <ul style="list-style-type: none"> 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) 	Influence of Science, Engineering, and Technology on Society and the Natural World <ul style="list-style-type: none"> 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)
<i>Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include: Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include:</i> Physical Science: MS-PS3-3 <i>Connections to MS-ETS1.B: Developing Possible Solutions Problems include:</i> Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5 <i>Connections to MS-ETS1.C: Optimizing the Design Solution include:</i> Physical Science: MS-PS1-6		
<i>Articulation of DCIs across grade-bands: 3-5.ETS1.A (MS-ETS1-1); 3-5.ETS1.C (MS-ETS1-1); HS.ETS1.A (MS-ETS1-1); HS.ETS1.B (MS-ETS1-1)</i>		
<i>Common Core State Standards Connections:</i> ELA/Literacy – RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1) WHST.6-8.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ETS1-1) Mathematics – MP.2 Reason abstractly and quantitatively. (MS-ETS1-1) 7.EE.3 Solve multi-step real-life 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; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1)		

MS. Engineering Design		
Students who demonstrate understanding can: MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. <ul style="list-style-type: none"> Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2) 	ETS1.B: Developing Possible Solutions <ul style="list-style-type: none"> There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2) 	N/A
<i>Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include:</i> Physical Science: MS-PS3-3 <i>Connections to MS-ETS1.B: Developing Possible Solutions Problems include:</i> Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5 <i>Connections to MS-ETS1.C: Optimizing the Design Solution include:</i> Physical Science: MS-PS1-6		
<i>Articulation of DCIs across grade-bands: 3-5.ETS1.A (MS-ETS1-2); 3-5.ETS1.B (MS-ETS1-2); 3-5.ETS1.C (MS-ETS1-2); HS.ETS1.A (MS-ETS1-2); HS.ETS1.B (MS-ETS1-2)</i>		
<i>Common Core State Standards Connections:</i> ELA/Literacy – RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-2) RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-2) WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2) WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ETS1-2) Mathematics – MP.2 Reason abstractly and quantitatively. (MS-ETS1-2) 7.EE.3 Solve multi-step real-life 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; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-2)		

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MS. Engineering Design		
Students who demonstrate understanding can: 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.		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<p style="text-align: center;">Science and Engineering Practices</p> <p>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.</p> <ul style="list-style-type: none"> Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none"> 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) <p>ETS1.C: Optimizing the Design Solution</p> <ul style="list-style-type: none"> 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) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>N/A</p>
<p><i>Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include:</i> Physical Science: MS-PS3-3</p> <p><i>Connections to MS-ETS1.B: Developing Possible Solutions Problems include:</i> Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5</p> <p><i>Connections to MS-ETS1.C: Optimizing the Design Solution include:</i> Physical Science: MS-PS1-6</p>		
<p><i>Articulation of DCIs across grade-bands: 3-5.ETS1.A (MS-ETS1-3); 3-5.ETS1.B (MS-ETS1-3); 3-5.ETS1.C (MS-ETS1-3); HS.ETS1.B (MS-ETS1-3); HS.ETS1.C (MS-ETS1-3)</i></p>		
<p><i>Common Core State Standards Connections:</i></p> <p><i>ELA/Literacy –</i></p> <p>RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-3)</p> <p>RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ETS1-3)</p> <p>RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-3)</p> <p><i>Mathematics –</i></p> <p>MP.2 Reason abstractly and quantitatively. (MS-ETS1-3)</p> <p>7.EE.3 Solve multi-step real-life 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; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-3)</p>		

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MS. Engineering Design		
Students who demonstrate understanding can: 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 <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. <ul style="list-style-type: none"> Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4) 	ETS1.B: Developing Possible Solutions <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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) 	N/A
<i>Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include:</i> Physical Science: MS-PS3-3 <i>Connections to MS-ETS1.B: Developing Possible Solutions Problems include:</i> Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5 <i>Connections to MS-ETS1.C: Optimizing the Design Solution include:</i> Physical Science: MS-PS1-6		
<i>Articulation of DCIs across grade-bands: 3-5.ETS1.B (MS-ETS1-4); 3-5.ETS1.C (MS-ETS1-4); HS.ETS1.B (MS-ETS1-4); HS.ETS1.C (MS-ETS1-4)</i>		
<i>Common Core State Standards Connections:</i> ELA/Literacy – SL.8.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ETS1-4) Mathematics – MP.2 Reason abstractly and quantitatively. (MS-ETS1-4)		
7.SP Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. (MS-ETS1-4)		

Unit of Study 5: Types of Interactions

Standards that appear this unit: MS-PS2-3, MS-PS2-4, MS-PS2-5

MS. Forces and Interactions		
Students who demonstrate understanding can:		
<p>MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]</p>		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<p>Science and Engineering Practices</p> <p>Asking Questions and Defining Problems</p> <p>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.</p> <ul style="list-style-type: none"> 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) 	<p>Disciplinary Core Ideas</p> <p>PS2.B: Types of Interactions</p> <ul style="list-style-type: none"> 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) 	<p>Crosscutting Concepts</p> <p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3)
Connections to other DCIs in this grade-band: N/A		
Articulation across grade-bands: 3.PS2.B (MS-PS2-3); HS.PS2.B (MS-PS2-3)		
Common Core State Standards Connections:		
<p><i>ELA/Literacy</i> –</p> <p>RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (MS-PS2-3)</p> <p><i>Mathematics</i> –</p> <p>MP.2 Reason abstractly and quantitatively. (MS-PS2-3)</p>		

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<p>MS. Forces and Interactions</p> <p>Students who demonstrate understanding can:</p> <p>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.]</p>		
<p>The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i>:</p>		
<p>Science and Engineering Practices</p> <p>Engaging in Argument from Evidence</p> <p>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.</p> <ul style="list-style-type: none"> 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) <p>-----</p> <p>Connections to Nature of Science</p> <p>Scientific Knowledge is Based on Empirical Evidence</p> <ul style="list-style-type: none"> Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS2-4) 	<p>Disciplinary Core Ideas</p> <p>PS2.B: Types of Interactions</p> <ul style="list-style-type: none"> 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) 	<p>Crosscutting Concepts</p> <p>Systems and System Models</p> <ul style="list-style-type: none"> 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)
<p><i>Connections to other DCIs in this grade-band:</i> MS.ESS1.A (MS-PS2-4); MS.ESS1.B (MS-PS2-4); MS.ESS2.C (MS-PS2-4)</p>		
<p><i>Articulation across grade-bands:</i> 5.PS2.B (MS-PS2-4); HS.PS2.B (MS-PS2-4); HS.ESS1.B (MS-PS2-4)</p>		
<p><i>Common Core State Standards Connections:</i></p> <p><i>ELA/Literacy –</i></p> <p>WHST.6-8.1 Write arguments focused on <i>discipline-specific content</i>. (MS-PS2-4)</p>		

MS. Forces and Interactions		
Students who demonstrate understanding can:		
<p>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.]</p>		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Planning and Carrying Out Investigations</p> <p>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.</p> <ul style="list-style-type: none"> 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) 	<p>PS2.B: Types of Interactions</p> <ul style="list-style-type: none"> 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) 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-5)
<i>Connections to other DCIs in this grade-band:</i> N/A		
<i>Articulation across grade-bands:</i> 3.PS2.B (MS-PS2-5); HS.PS2.B (MS-PS2-5); HS.PS3.A (MS-PS2-5); HS.PS3.B (MS-PS2-5); HS.PS3.C (MS-PS2-5)		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS2-5)	
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS2-5)	

Unit of Study 6: Earth and Space

Standards that appear this unit: MS-ESS1-1, MS-ESS1-2, MS-ESS1-3

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 can be physical, graphical, or conceptual.]		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<p style="text-align: center;">Science and Engineering Practices</p> <p>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.</p> <ul style="list-style-type: none"> Develop and use a model to describe phenomena. (MS-ESS1-1) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>ESS1.A: The Universe and Its Stars</p> <ul style="list-style-type: none"> 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) <p>ESS1.B: Earth and the Solar System</p> <ul style="list-style-type: none"> 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) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Patterns</p> <ul style="list-style-type: none"> Patterns can be used to identify cause and effect relationships. (MS-ESS1-1) <p style="text-align: center;">-----</p> <p style="text-align: center;">Connections to Nature of Science</p> <p>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</p> <ul style="list-style-type: none"> Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-ESS1-1)
Connections to other DCIs in this grade-band: MS.PS2.A (MS-ESS1-1); MS.PS2.B (MS-ESS1-1)		
Articulation of DCIs across grade-bands: 3.PS2.A (MS-ESS1-1); 5.PS2.B (MS-ESS1-1); 5.ESS1.B (MS-ESS1-1); HS.PS2.A (MS-ESS1-1); HS.PS2.B (MS-ESS1-1); HS.ESS1.B (MS-ESS1-1)		
Common Core State Standards Connections:		
ELA/Literacy –		
SL.8.5	Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS1-1)	
Mathematics –		
MP.4	Model with mathematics. (MS-ESS1-1)	
6.RP.A.1	Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-1)	
7.RP.A.2	Recognize and represent proportional relationships between quantities. (MS-ESS1-1)	

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MS. Space Systems		
Students who demonstrate understanding can:		
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 can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (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.]		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. <ul style="list-style-type: none"> Develop and use a model to describe phenomena. (MS-ESS1-2) 	ESS1.A: The Universe and Its Stars <ul style="list-style-type: none"> Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2) ESS1.B: Earth and the Solar System <ul style="list-style-type: none"> The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2) The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2) 	Systems and System Models <ul style="list-style-type: none"> Models can be used to represent systems and their interactions. (MS-ESS1-2) <hr style="border-top: 1px dashed black;"/> Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems <ul style="list-style-type: none"> Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-ESS1-2)
<i>Connections to other DCIs in this grade-band: MS.PS2.A (MS-ESS1-2); MS.PS2.B (MS-ESS1-2);</i>		
<i>Articulation of DCIs across grade-bands: 3.PS2.A (MS-ESS1-2); 5.PS2.B (MS-ESS1-2); 5.ESS1.A (MS-ESS1-2); 5.ESS1.B (MS-ESS1-2); HS.PS2.A (MS-ESS1-2); HS.PS2.B (MS-ESS1-2); HS.ESS1.A (MS-ESS1-2); HS.ESS1.B (MS-ESS1-2)</i>		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
SL.8.5	Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS1-2)	
<i>Mathematics –</i>		
MP.4	Model with mathematics. (MS-ESS1-2)	
6.RP.A.1	Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-2)	
7.RP.A.2	Recognize and represent proportional relationships between quantities. (MS-ESS1-2)	
6.EE.B.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)	
7.EE.B.4	Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-2)	

MS. Space Systems		
Students who demonstrate understanding can:		
<p>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 include the sizes of an object’s layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data 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.]</p>		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>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.</p> <ul style="list-style-type: none"> Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3) 	<p>ESS1.B: Earth and the Solar System</p> <ul style="list-style-type: none"> The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-3) 	<p>Scale, Proportion, and Quantity</p> <ul style="list-style-type: none"> 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) <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;">Connections to Engineering, Technology, and Applications of Science</p> <p>Interdependence of Science, Engineering, and Technology</p> <ul style="list-style-type: none"> 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-ESS1-3)
<p><i>Connections to other DCIs in this grade-band:</i> MS.ESS2.A (MS-ESS1-3)</p> <p><i>Articulation of DCIs across grade-bands:</i> 5.ESS1.B (MS-ESS1-3); HS.ESS1.B (MS-ESS1-3); HS.ESS2.A (MS-ESS1-3)</p>		
<p><i>Common Core State Standards Connections:</i></p> <p><i>ELA/Literacy –</i></p> <p>RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-3)</p> <p>RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS1-3)</p> <p><i>Mathematics –</i></p> <p>MP.2 Reason abstractly and quantitatively. (MS-ESS1-3)</p> <p>6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-3)</p> <p>7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-ESS1-3)</p>		

Unit of Study 7: Weather and Climate

Standards that appear this unit: MS-ESS2-4, MS-ESS2-5, MS-ESS2-6

MS. Earth's Systems		
<p>Students who demonstrate understanding can:</p> <p>MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]</p>		
<p>The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i>:</p>		
<p>Science and Engineering Practices</p> <p>Developing and Using Models</p> <p>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.</p> <ul style="list-style-type: none"> ▪ Develop a model to describe unobservable mechanisms. (MS-ESS2-4) 	<p>Disciplinary Core Ideas</p> <p>ESS2.C: The Roles of Water in Earth's Surface Processes</p> <ul style="list-style-type: none"> ▪ Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4) ▪ Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4) 	<p>Crosscutting Concepts</p> <p>Energy and Matter</p> <ul style="list-style-type: none"> ▪ Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)
<p><i>Connections to other DCIs in this grade-band:</i> MS.PS1.A (MS-ESS2-4); MS.PS2.B (MS-ESS2-4); MS.PS3.A (MS-ESS2-4); MS.PS3.D (MS-ESS2-4)</p>		
<p><i>Articulation of DCIs across grade-bands:</i> 3.PS2.A (MS-ESS2-4); 4.PS3.B (MS-ESS2-4); 5.PS2.B (MS-ESS2-4); 5.ESS2.C (MS-ESS2-4); HS.PS2.B (MS-ESS2-4); HS.PS3.B (MS-ESS2-4); HS.PS4.B (MS-ESS2-4); HS.ESS2.A (MS-ESS2-4); HS.ESS2.C (MS-ESS2-4); HS.ESS2.D (MS-ESS2-4)</p>		
<p><i>Common Core State Standards Connections:</i> N/A</p>		

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MS. Weather and Climate		
Students who demonstrate understanding can:		
<p>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 masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of 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 does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]</p>		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Planning and Carrying Out Investigations</p> <p>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.</p> <ul style="list-style-type: none"> 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) 	<p>ESS2.C: The Roles of Water in Earth’s Surface Processes</p> <ul style="list-style-type: none"> The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5) <p>ESS2.D: Weather and Climate</p> <ul style="list-style-type: none"> Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5) 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)
<p><i>Connections to other DCIs in this grade-band:</i> MS.PS1.A (MS-ESS2-5); MS.PS2.A (MS-ESS2-5); MS.PS3.A (MS-ESS2-5); MS.PS3.B (MS-ESS2-5)</p>		
<p><i>Articulation of DCIs across grade-bands:</i> 3.ESS2.D (MS-ESS2-5); 5.ESS2.A (MS-ESS2-5); HS.ESS2.C (MS-ESS2-5); HS.ESS2.D (MS-ESS2-5)</p>		
<p><i>Common Core State Standards Connections:</i></p> <p><i>ELA/Literacy –</i></p> <p>RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-5)</p> <p>RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-5)</p> <p>WHST.6-8.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ESS2-5)</p> <p><i>Mathematics –</i></p> <p>MP.2 Reason abstractly and quantitatively. (MS-ESS2-5)</p> <p>6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)</p>		

MS. Weather and Climate		
Students who demonstrate understanding can:		
<p>MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.</p> <p>[Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, 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 outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.]</p> <p>[Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]</p>		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
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. <ul style="list-style-type: none"> Develop and use a model to describe phenomena. (MS-ESS2-6) 	Disciplinary Core Ideas ESS2.C: The Roles of Water in Earth’s Surface Processes <ul style="list-style-type: none"> Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6) ESS2.D: Weather and Climate <ul style="list-style-type: none"> Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6) The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6) 	Crosscutting Concepts Systems and System Models <ul style="list-style-type: none"> Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6)
<i>Connections to other DCIs in this grade-band:</i> MS.PS2.A (MS-ESS2-6); MS.PS3.B (MS-ESS2-6); MS.PS4.B (MS-ESS2-6)		
<i>Articulation of DCIs across grade-bands:</i> 3.PS2.A (MS-ESS2-6); 3.ESS2.D (MS-ESS2-6); 5.ESS2.A (MS-ESS2-6); HS.PS2.B (MS-ESS2-6); HS.PS3.B (MS-ESS2-6); HS.PS3.D (MS-ESS2-6); HS.ESS1.B (MS-ESS2-6); HS.ESS2.A (MS-ESS2-6); HS.ESS2.D (MS-ESS2-6)		
<i>Common Core State Standards Connections:</i> ELA/Literacy – SL.8.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS2-6)		

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