

Grade 8 Science

Scope and Sequence

Unit of Study 1: Evidence of Common Ancestry

Standards that appear this unit: MS-LS4-1, MS-LS4-2, MS-LS4-3

MS. Natural Selection and Adaptations		
<p>Students who demonstrate understanding can:</p> <p>MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.]</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>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-LS4-1) <p>-----</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-LS4-1) 	<p>Disciplinary Core Ideas</p> <p>LS4.A: Evidence of Common Ancestry and Diversity</p> <ul style="list-style-type: none"> ▪ The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1) 	<p>Crosscutting Concepts</p> <p>Patterns</p> <ul style="list-style-type: none"> ▪ Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1) <p>-----</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-LS4-1)
<p><i>Connections to other DCIs in this grade-band: MS.ESS1.C (MS-LS4-1); MS.ESS2.B (MS-LS4-1)</i></p>		
<p><i>Articulation across grade-bands: 3.LS4.A (MS-LS4-1); HS.LS4.A (MS-LS4-1); HS.ESS1.C (MS-LS4-1)</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, attending to the precise details of explanations or descriptions (MS-LS4-1)</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-LS4-1)</p> <p><i>Mathematics –</i></p> <p>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-LS4-1)</p>		

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MS. Natural Selection and Adaptations		
Students who demonstrate understanding can:		
MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.]		
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"> Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2) 	LS4.A: Evidence of Common Ancestry and Diversity <ul style="list-style-type: none"> Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2) 	Patterns <ul style="list-style-type: none"> Patterns can be used to identify cause and effect relationships. (MS-LS4-2) <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;">Connections to Nature of Science</p> 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-LS4-2)
<i>Connections to other DCIs in this grade-band:</i> MS.LS3.A (MS-LS4-2); MS.LS3.B (MS-LS4-2); MS.ESS1.C (MS-LS4-2)		
<i>Articulation across grade-bands:</i> 3.LS4.A (MS-LS4-2); HS.LS4.A (MS-LS4-2); HS.ESS1.C (MS-LS4-2)		
<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, attending to the precise details of explanations or descriptions (MS-LS4-2)	
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-LS4-2)	
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS4-2)	
SL.8.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others’ ideas and expressing their own clearly. (MS-LS4-2)	
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-LS4-2)	
<i>Mathematics –</i>		
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-LS4-2)	

MS. Natural Selection and Adaptations		
Students who demonstrate understanding can:		
MS-LS4-3. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]		
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
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. <ul style="list-style-type: none"> ▪ Analyze displays of data to identify linear and nonlinear relationships. (MS-LS4-3) 	LS4.A: Evidence of Common Ancestry and Diversity <ul style="list-style-type: none"> ▪ Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3) 	Patterns <ul style="list-style-type: none"> ▪ Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-3)
<i>Connections to other DCIs in this grade-band: N/A</i>		
<i>Articulation across grade-bands: HS.LS4.A (MS-LS4-3)</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-LS4-3)	
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-LS4-3)	
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-LS4-3)	

Unit of Study 2: Selection and Adaptation

Standards that appear this unit: MS-LS4-4, MS-LS4-5, MS-LS4-6

MS. Natural Selection and Adaptations		
Students who demonstrate understanding can:		
MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations]		
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 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 describe phenomena. (MS-LS4-4) 	Disciplinary Core Ideas LS4.B: Natural Selection <ul style="list-style-type: none"> ▪ Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4) 	Crosscutting Concepts 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-LS4-4)
Connections to other DCIs in this grade-band: MS.LS2.A (MS-LS4-4); MS.LS3.A (MS-LS4-4); MS.LS3.B (MS-LS4-4)		
Articulation across grade-bands: 3.LS3.B (MS-LS4-4); 3.LS4.B (MS-LS4-4); HS.LS2.A (MS-LS4-4); HS.LS3.B (MS-LS4-4); HS.LS4.B (MS-LS4-4); HS.LS4.C (MS-LS4-4)		
Common Core State Standards Connections:		
ELA/Literacy –		
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-LS4-4)	
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-LS4-4)	
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-LS4-4)	
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS4-4)	
SL.8.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS4-4)	
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-LS4-4)	
Mathematics –		
6.RP.A.1	Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-LS4-4)	
6.SP.B.5	Summarize numerical data sets in relation to their context. (MS-LS4-4)	
7.RP.A.2	Recognize and represent proportional relationships between quantities. (MS-LS4-4)	

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MS. Growth, Development, and Reproduction of Organisms		
Students who demonstrate understanding can:		
MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]		
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>Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.</p> <ul style="list-style-type: none"> Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS4-5) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>LS4.B: Natural Selection</p> <ul style="list-style-type: none"> In <i>artificial</i> selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5) 	<p style="text-align: center;">Crosscutting Concepts</p> <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-LS4-5) <hr/> <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-LS4-5) <hr/> <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-LS4-5)
<i>Connections to other DCIs in this grade-band:</i> N/A		
<i>Articulation to DCIs across grade-bands:</i> HS.LS3.B (MS-LS4-5); HS.LS4.C (MS-LS4-5)		
<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-LS4-5)	
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-LS4-5)	

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MS. Natural Selection and Adaptations		
Students who demonstrate understanding can:		
MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]		
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
Using Mathematics and Computational Thinking Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. <ul style="list-style-type: none"> ▪ Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6) 	LS4.C: Adaptation <ul style="list-style-type: none"> ▪ Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6) 	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-LS4-6)
<i>Connections to other DCIs in this grade-band:</i> MS.LS2.A (MS-LS4-6); MS.LS2.C (MS-LS4-6); MS.LS3.B (MS-LS4-6); MS.ESS1.C (MS-LS4-6)		
<i>Articulation across grade-bands:</i> 3.LS4.C (MS-LS4-6); HS.LS2.A (MS-LS4-6); HS.LS2.C (MS-LS4-6); HS.LS3.B (MS-LS4-6); HS.LS4.B (MS-LS4-6); HS.LS4.C (MS-LS4-6)		
<i>Common Core State Standards Connections:</i> <i>Mathematics –</i>		
MP.4 Model with mathematics. (MS-LS4-6)		
6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-LS4-6)		
6.SP.B.5 Summarize numerical data sets in relation to their context. (MS-LS4-6)		
7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-LS4-6)		

Unit of Study 3: Stability and Change of Earth

Standards that appear this unit: MS-ESS3-1, MS-ESS3-2, MS-ESS3-4, MS-ESS3-5

MS. Earth's Systems		
<p>Students who demonstrate understanding can:</p> <p>MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]</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 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"> Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>ESS3.A: Natural Resources</p> <ul style="list-style-type: none"> Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1) 	<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-ESS3-1) <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"> All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1)
<p><i>Connections to other DCIs in this grade-band:</i> MS.PS1.A (MS-ESS3-1); MS.PS1.B (MS-ESS3-1); MS.ESS2.D (MS-ESS3-1)</p>		
<p><i>Articulation of DCIs across grade-bands:</i> 4.PS3.D (MS-ESS3-1); 4.ESS3.A (MS-ESS3-1); HS.PS3.B (MS-ESS3-1); HS.LS1.C (MS-ESS3-1); HS.ESS2.A (MS-ESS3-1); HS.ESS2.B (MS-ESS3-1); HS.ESS2.C (MS-ESS3-1); HS.ESS3.A (MS-ESS3-1)</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-ESS3-1)</p> <p>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-ESS3-1)</p> <p>WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1)</p> <p><i>Mathematics –</i></p> <p>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-ESS3-1)</p> <p>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-ESS3-1)</p>		

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<p>MS. Human Impacts</p> <p>Students who demonstrate understanding can:</p> <p>MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]</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>Disciplinary Core Ideas</p>	<p>Crosscutting Concepts</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-ESS3-2) 	<p>ESS3.B: Natural Hazards</p> <ul style="list-style-type: none"> Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2) 	<p>Patterns</p> <ul style="list-style-type: none"> Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2) <p>-----</p> <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 uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-2)
<p><i>Connections to other DCIs in this grade-band:</i> MS.PS3.C (MS-ESS3-2)</p>		
<p><i>Articulation of DCIs across grade-bands:</i> 3.ESS3.B (MS-ESS3-2); 4.ESS3.B (MS-ESS3-2); HS.ESS2.B (MS-ESS3-2); HS.ESS2.D (MS-ESS3-2); HS.ESS3.B (MS-ESS3-2); HS.ESS3.D (MS-ESS3-2)</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-ESS3-2)</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-ESS3-2)</p> <p><i>Mathematics –</i></p> <p>MP.2 Reason abstractly and quantitatively. (MS-ESS3-2)</p> <p>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-ESS3-2)</p> <p>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-ESS3-2)</p>		

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MS. Human Impacts		
<p>Students who demonstrate understanding can:</p> <p>MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth’s systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]</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 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"> Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>ESS3.C: Human Impacts on Earth Systems</p> <ul style="list-style-type: none"> Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-4) 	<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-ESS3-4) <p style="text-align: center;">-----</p> <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"> All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-4) <p style="text-align: center;">-----</p> <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-ESS3-4)
<p><i>Connections to other DCIs in this grade-band:</i> MS.LS2.A (MS-ESS3-4); MS.LS2.C (MS-ESS3-4); MS.LS4.D (MS-ESS3-4)</p>		
<p><i>Articulation of DCIs across grade-bands:</i> 3.LS2.C (MS-ESS3-4); 3.LS4.D (MS-ESS3-4); 5.ESS3.C (MS-ESS3-4); HS.LS2.A (MS-ESS3-4); HS.LS2.C (MS-ESS3-4); HS.LS4.C (MS-ESS3-4); HS.LS4.D (MS-ESS3-4); HS.ESS2.E (MS-ESS3-4); HS.ESS3.A (MS-ESS3-4); HS.ESS3.C (MS-ESS3-4)</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-ESS3-4)</p> <p>WHST.6-8.1 Write arguments focused on discipline content. (MS-ESS3-4)</p> <p>WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-4)</p> <p><i>Mathematics –</i></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-ESS3-4)</p> <p>7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-ESS3-4)</p> <p>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-ESS3-4)</p> <p>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-ESS3-4)</p>		

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MS. Weather and Climate		
Students who demonstrate understanding can: MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]		
The performance expectations above were developed using the following elements from the NRC document <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 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. <ul style="list-style-type: none"> ▪ Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5) 	ESS3.D: Global Climate Change <ul style="list-style-type: none"> ▪ Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth’s mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5) 	Stability and Change <ul style="list-style-type: none"> ▪ Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)
<i>Connections to other DCIs in this grade-band:</i> MS.PS3.A (MS-ESS3-5)		
<i>Articulation of DCIs across grade-bands:</i> HS.PS3.B (MS-ESS3-5); HS.PS4.B (MS-ESS3-5); HS.ESS2.A (MS-ESS3-5); HS.ESS2.D (MS-ESS3-5); HS.ESS3.C (MS-ESS3-5); HS.ESS3.D (MS-ESS3-5)		
<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-ESS3-5)	
<i>Mathematics –</i>		
MP.2	Reason abstractly and quantitatively. (MS-ESS3-5)	
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-ESS3-5)	
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-ESS3-5)	

Unit of Study 4: Human Impacts on Earth Systems and Global Climate Change

Standards that appear this unit: MS-ESS3-3*, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3

MS. Human Impacts		
<p>Students who demonstrate understanding can:</p> <p>MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]</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>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 principles to design an object, tool, process or system. (MS-ESS3-3) 	<p>Disciplinary Core Ideas</p> <p>ESS3.C: Human Impacts on Earth Systems</p> <ul style="list-style-type: none"> ▪ Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) ▪ Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3) 	<p>Crosscutting Concepts</p> <p>Cause and Effect</p> <ul style="list-style-type: none"> ▪ Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3) <p style="text-align: center;">-----</p> <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 uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-3)
<p><i>Connections to other DCIs in this grade-band:</i> MS.LS2.A (MS-ESS3-3); MS.LS2.C (MS-ESS3-3); MS.LS4.D (MS-ESS3-3)</p>		
<p><i>Articulation of DCIs across grade-bands:</i> 3.LS2.C (MS-ESS3-3); 3.LS4.D (MS-ESS3-3); 5.ESS3.C (MS-ESS3-3); HS.LS2.C (MS-ESS3-3); HS.LS4.C (MS-ESS3-3); HS.LS4.D (MS-ESS3-3); HS.ESS2.C (MS-ESS3-3); HS.ESS2.D (MS-ESS3-3); HS.ESS2.E (MS-ESS3-3); HS.ESS3.C (MS-ESS3-3); HS.ESS3.D (MS-ESS3-3)</p>		
<p><i>Common Core State Standards Connections:</i></p> <p><i>ELA/Literacy –</i></p> <p>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-ESS3-3)</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-ESS3-3)</p> <p><i>Mathematics –</i></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-ESS3-3)</p> <p>7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-ESS3-3)</p> <p>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-ESS3-3)</p> <p>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-ESS3-3)</p>		

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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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Unit of Study 5: Relationships Among Forms of Energy

Standards that appear this unit: MS-PS3-1, MS-PS3-2, MS-PS3-5

MS. Energy		
Students who demonstrate understanding can:		
<p>MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.]</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 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"> Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1) 	<p>PS3.A: Definitions of Energy</p> <ul style="list-style-type: none"> 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) 	<p>Scale, Proportion, and Quantity</p> <ul style="list-style-type: none"> 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)
<p><i>Connections to other DCIs in this grade-band:</i> MS.PS2.A (MS-PS3-1)</p>		
<p><i>Articulation across grade-bands:</i> 4.PS3.B (MS-PS3-1); HS.PS3.A (MS-PS3-1); HS.PS3.B (MS-PS3-1)</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, attending to the precise details of explanations or descriptions (<i>MS-PS3-1</i>)</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-PS3-1)</p>		
<p><i>Mathematics –</i></p>		
<p>MP.2 Reason abstractly and quantitatively. (MS-PS3-1)</p>		
<p>6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-1)</p>		
<p>6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. (<i>MS-PS3-1</i>)</p>		
<p>7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS3-1)</p>		
<p>8.EE.A.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)</p>		
<p>8.EE.A.2 Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational. (<i>MS-PS3-1</i>)</p>		
<p>8.F.A.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1)</p>		

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MS. Energy		
Students who demonstrate understanding can:		
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.]		
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 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 describe unobservable mechanisms. (MS-PS3-2) 	PS3.A: Definitions of Energy <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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) 	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 and matter flows within systems. (MS-PS3-2)
<i>Connections to other DCIs in this grade-band:</i> N/A		
<i>Articulation across grade-bands:</i> HS.PS2.B (MS-PS3-2); HS.PS3.B (MS-PS3-2); HS.PS3.C (MS-PS3-2)		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)		

<p>MS. Energy</p> <p>Students who demonstrate understanding can:</p> <p>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.]</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 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.</p> <ul style="list-style-type: none"> 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) <hr/> <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-PS3-5) 	<p>Disciplinary Core Ideas</p> <p>PS3.B: Conservation of Energy and Energy Transfer</p> <ul style="list-style-type: none"> When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5) 	<p>Crosscutting Concepts</p> <p>Energy and Matter</p> <ul style="list-style-type: none"> Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3-5)
<p><i>Connections to other DCIs in this grade-band:</i> MS.PS2.A (MS-PS3-5)</p>		
<p><i>Articulation across grade-bands:</i> 4.PS3.C (MS-PS3-5); HS.PS3.A (MS-PS3-5); HS.PS3.B (MS-PS3-5)</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, attending to the precise details of explanations or descriptions (MS-PS3-5)</p> <p>WHST.6-8.1 Write arguments focused on discipline content. (MS-PS3-5)</p> <p><i>Mathematics –</i></p> <p>MP.2 Reason abstractly and quantitatively. (MS-PS3-5)</p> <p>6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-5)</p> <p>7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS3-5)</p> <p>8.F.A.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-5)</p>		

Unit of Study 6: Thermal Energy

Standards that appear this unit: MS-PS3-3, MS-ETS1-2, MS-PS3-4, MS-ETS1-3, MS-ETS1-1, MS-ETS1-4

MS. Energy		
<p>Students who demonstrate understanding can:</p> <p>MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]</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>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, construct, and test a design of an object, tool, process or system. (MS-PS3-3) 	<p>Disciplinary Core Ideas</p> <p>PS3.A: Definitions of Energy</p> <ul style="list-style-type: none"> Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3) <p>PS3.B: Conservation of Energy and Energy Transfer</p> <ul style="list-style-type: none"> Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3) <p>ETS1.A: Defining and Delimiting an Engineering Problem</p> <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 is likely to limit possible solutions. <i>(secondary to MS-PS3-3)</i> <p>ETS1.B: Developing Possible Solutions</p> <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. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. <i>(secondary to MS-PS3-3)</i> 	<p>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 designed or natural system. (MS-PS3-3)

Connections to other DCIs in this grade-band: **MS.PS1.B** (MS-PS3-3); **MS.ESS2.A** (MS-PS3-3); **MS.ESS2.C** (MS-PS3-3); **MS.ESS2.D** (MS-PS3-3)

Articulation across grade-bands: **4.PS3.B** (MS-PS3-3); **HS.PS3.B** (MS-PS3-3)

Common Core State Standards Connections:

ELA/Literacy –

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (*MS-PS3-3*)

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-PS3-3*)

MS. Energy		
Students who demonstrate understanding can:		
MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]		
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"> 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-PS3-4) <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-PS3-4) 	<p>PS3.A: Definitions of Energy</p> <ul style="list-style-type: none"> Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-4) <p>PS3.B: Conservation of Energy and Energy Transfer</p> <ul style="list-style-type: none"> The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4) 	<p>Scale, Proportion, and Quantity</p> <ul style="list-style-type: none"> 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-PS3-4)
<i>Connections to other DCIs in this grade-band:</i> MS.PS1.A (MS-PS3-4); MS.PS2.A (MS-PS3-4); MS.ESS2.C (MS-PS3-4); MS.ESS2.D (MS-PS3-4); MS.ESS3.D (MS-PS3-4)		
<i>Articulation across grade-bands:</i> 4.PS3.C (MS-PS3-4); HS.PS1.B (MS-PS3-4); HS.PS3.A (MS-PS3-4); HS.PS3.B (MS-PS3-4)		
<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-PS3-4)	
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-PS3-4)	
<i>Mathematics –</i>		
MP.2	Reason abstractly and quantitatively. (MS-PS3-4)	
6.SP.B.5	Summarize numerical data sets in relation to their context. (MS-PS3-4)	

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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 7: The Electromagnetic Spectrum

Standards that appear this unit: MS-PS4-1, MS-PS4-2, MS-PS4-3

MS. Waves and Electromagnetic Radiation		
Students who demonstrate understanding can:		
<p>MS-PS4-1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.]</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 Using Mathematics and Computational Thinking Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.</p> <ul style="list-style-type: none"> ▪ Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1) <hr style="border-top: 1px dashed black;"/> <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-PS4-1) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>PS4.A: Wave Properties</p> <ul style="list-style-type: none"> ▪ A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Patterns</p> <ul style="list-style-type: none"> ▪ Graphs and charts can be used to identify patterns in data. (MS-PS4-1)
Connections to other DCIs in this grade-band: N/A		
Articulation across grade-bands: 4.PS3.A (MS-PS4-1); 4.PS3.B (MS-PS4-1); 4.PS4.A (MS-PS4-1); HS.PS4.A (MS-PS4-1); HS.PS4.B (MS-PS4-1)		
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-PS4-1)</p> <p><i>Mathematics</i> –</p> <p>MP.2 Reason abstractly and quantitatively. (MS-PS4-1)</p> <p>MP.4 Model with mathematics. (MS-PS4-1)</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-PS4-1)</p> <p>6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS4-1)</p> <p>7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS4-1)</p> <p>8.F.A.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS4-1)</p>		

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MS. Waves and Electromagnetic Radiation		
Students who demonstrate understanding can:		
MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]		
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 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-PS4-2) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>PS4.A: Wave Properties</p> <ul style="list-style-type: none"> A sound wave needs a medium through which it is transmitted. (MS-PS4-2) <p>PS4.B: Electromagnetic Radiation</p> <ul style="list-style-type: none"> When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object’s material and the frequency (color) of the light. (MS-PS4-2) The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2) A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Structure and Function</p> <ul style="list-style-type: none"> Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS4-2)
<i>Connections to other DCIs in this grade-band:</i> MS.LS1.D (MS-PS4-2)		
<i>Articulation across grade-bands:</i> 4.PS4.B (MS-PS4-2); HS.PS4.A (MS-PS4-2); HS.PS4.B (MS-PS4-2); HS.ESS1.A (MS-PS4-2); HS.ESS2.A (MS-PS4-2); HS.ESS2.C (MS-PS4-2); HS.ESS2.D (MS-PS4-2)		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-2)		

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MS. Waves and Electromagnetic Radiation		
Students who demonstrate understanding can:		
MS-PS4-3. Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. [Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<p style="text-align: center;">Science and Engineering Practices</p> <p>Obtaining, Evaluating, and Communicating Information</p> <p>Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods.</p> <ul style="list-style-type: none"> Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>PS4.C: Information Technologies and Instrumentation</p> <ul style="list-style-type: none"> Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Structure and Function</p> <ul style="list-style-type: none"> Structures can be designed to serve particular functions. (MS-PS4-3) <p style="text-align: center;">-----</p> <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"> Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3) <p style="text-align: center;">-----</p> <p style="text-align: center;">Connections to Nature of Science</p> <p>Science is a Human Endeavor</p> <ul style="list-style-type: none"> Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)
<i>Connections to other DCIs in this grade-band:</i> N/A		
<i>Articulation across grade-bands:</i> 4.PS4.C (MS-PS4-3); HS.PS4.A (MS-PS4-3); HS.PS4.C (MS-PS4-3)		
<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-PS4-3)	
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-PS4-3)	
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-PS4-3)	
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research. (MS-PS4-3)	

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