California Department of Education
Next Generation Science Standards for California Public Schools, Kindergarten through Grade Twelve

Grade Six – Integrated Course
Standards Arranged by Topic

California Department of Education
Clarification statements were created by the writers of NGSS to supply examples or additional clarification to the performance expectations and assessment boundary statements.
*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.
**California clarification statements, marked with double asterisks, were incorporated by the California Science Expert Review Panel.
The section entitled "Disciplinary Core Ideas" is reproduced verbatim from *A Framework for K–12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas*. Revised March 2015.

MS Structure, Function, and Information Processing

MS Structure, Function, and Information Processing

Students who demonstrate understanding can:

MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. [Clarification Statement: Emphasis is on developing evidence that living things **(**including Bacteria, Archaea, and Eukarya)** are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells. (****Viruses, while not cells, have features that are both common with, and distinct from, cellular life.**]

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

MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. [Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.] [Assessment Boundary: Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.]

MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. [Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.]

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

Science and Engineering Practices	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. ▪ Develop and use a model to describe phenomena. (MS-LS1-2) **Planning and Carrying Out Investigations** Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. ▪ Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. (MS-LS1-1) **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	**LS1.A: Structure and Function** ▪ All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1) ▪ Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2) ▪ In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3) **LS1.D: Information Processing** ▪ Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting	**Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8) **Scale, Proportion, and Quantity** ▪ Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1) **Systems and System Models** ▪ Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3) **Structure and Function** ▪ Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS1-2) -- ***Connections to Engineering, Technology,***

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explanations or solutions about the natural and designed world(s). ▪ Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods. ▪ Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS1-8)	them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (MS-LS1-8)	***and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ▪ Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS1-1) **---** ***Connections to Nature of Science*** **Science is a Human Endeavor** ▪ Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-3)

Connections to other DCIs in this grade-band: **MS.LS3.A** (MS-LS1-2)
Articulation to DCIs across grade-bands: **4.LS1.A** (MS-LS1-2); **4.LS1.D** (MS-LS1-8); **HS.LS1.A** (MS-LS1-1),(MS-LS1-2),(MS-LS1-3),(MS-LS1-8)
California Common Core State Standards Connections: *ELA/Literacy –* **RST.6–8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-3) **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-LS1-3)
WHST.6–8.1.a–e	Write arguments focused on *discipline-specific content*. (MS-LS1-3)
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-LS1-1)
WHST.6–8.8	Gather relevant information from multiple print and digital sources **(primary and secondary)**, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. **CA** (MS-LS1-8)
SL.8.5	Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS1-2)
Mathematics –	
6.EE.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-LS1-1),(MS-LS1-2),(MS-LS1-3)

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MS Growth, Development, and Reproduction of Organisms

MS Growth, Development, and Reproduction of Organisms
Students who demonstrate understanding can: **MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.** [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, 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.] **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.] **MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.** [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]
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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. ▪ Develop and use a model to describe phenomena. (MS-LS3-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories. ▪ Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-5)	**LS1.B: Growth and Development of Organisms** ▪ Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-LS3-2) ▪ 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) ▪ Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5) ▪ Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2) **LS3.B: Variation of Traits** ▪ In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring.	**Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2) ▪ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS1-4),(MS-LS1-5)

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Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). ▪ 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)	Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2)	
Connections to other DCIs in this grade-band: **MS.LS2.A** (MS-LS1-4),(MS-LS1-5)		
Articulation to DCIs across grade-bands: **3.LS1.B** (MS-LS1-4),(MS-LS1-5); **3.LS3.A** (MS-LS1-5), (MS-LS3-2); **3.LS3.B** (MS-LS3-2); **HS.LS1.A HS.LS1.B** (MS-LS3-2); **HS.LS2.A** (MS-LS1-4),(MS-LS1-5); **HS.LS2.D** (MS-LS1-4); **HS.LS3.A** (MS-LS3-2); **HS.LS3.B** (MS-LS3-2)		

California Common Core State Standards Connections:
ELA/Literacy –

RST.6–8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-4),(MS-LS1-5),(MS-LS3-2)
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)
RST.6–8.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics. (MS-LS3-2)
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-LS3-2)
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.a–e	Write arguments focused on *discipline-specific content*. (MS-LS1-4)
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-LS1-5)
WHST.6–8.9.a–f	Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-5)
SL.8.5	Integrate multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-LS3-2)
Mathematics –	
MP.4	Model with mathematics. (MS-LS3-2)
6.SP.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),(MS-LS1-5)
6.SP.4	Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (MS-LS1-4),(MS-LS1-5)
6.SP.5.a-d	Summarize numerical data sets in relation to their context. (MS-LS3-2)

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MS Earth's Systems

MS Earth's Systems		
Students who demonstrate understanding can: **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.]		
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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. ▪ Develop a model to describe unobservable mechanisms. (MS-ESS2-4)	**ESS2.C: The Roles of Water in Earth's Surface Processes** ▪ 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)	**Energy and Matter** ▪ Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)
Connections to other DCIs in this grade-band: **MS.PS1.A** (MS-ESS2-4); **MS.PS2.B** (MS-ESS2-4); **MS.PS3.A** (MS-ESS2-4); **MS.PS3.D** (MS-ESS2-4)		
Articulation of DCIs across grade-bands: **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)		
California Common Core State Standards Connections: N/A		

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MS Weather and Climate

MS Weather and Climate		
Students who demonstrate understanding can: **MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.** [Clarification Statement: Emphasis is on how air 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.] **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.** [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.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.] **MS-ESS3–5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.** [Clarification Statement: Examples of factors 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.]		
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Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**

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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. ▪ Ask questions to identify and clarify evidence of an argument. (MS-ESS3–5) **Developing and Using Models** Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop and use a model to describe phenomena. (MS-ESS2-6) **Planning and Carrying Out Investigations** Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. ▪ Collect data to produce data to serve	**ESS2.C: The Roles of Water in Earth's Surface Processes** ▪ The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5) ▪ Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6) **ESS2.D: Weather and Climate** ▪ Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6) ▪ Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5) ▪ The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6) **ESS3.D: Global Climate Change** ▪ Human activities, such as the release of	**Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5) **Systems and System Models** ▪ Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6) **Stability and Change** ▪ Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3–5)

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

Connections to other DCIs in this grade-band: **MS.PS1.A** (MS-ESS2-5); **MS.PS2.A** (MS-ESS2-5),(MS-ESS2-6); **MS.PS3.A** (MS-ESS2-5),(MS-ESS3–5); **MS.PS3.B** (MS-ESS2-5),(MS-ESS2-6); **MS.PS4.B** (MS-ESS2-6)

Articulation of DCIs across grade-bands: **3.PS2.A** (MS-ESS2-6); **3.ESS2.D** (MS-ESS2-5),(MS-ESS2-6); **5.ESS2.A** (MS-ESS2-5),(MS-ESS2-6); **HS.PS2.B** (MS-ESS2-6); **HS.PS3.B** (MS-ESS2-6),(MS-ESS3–5); **HS.PS3.D** (MS-ESS2-6); **HS.PS4.B** (MS-ESS3–5); **HS.ESS1.B** (MS-ESS2-6); **HS.ESS2.A** (MS-ESS2-6),(MS-ESS3–5); **HS.ESS2.C** (MS-ESS2-5); **HS.ESS2.D** (MS-ESS2-5),(MS-ESS2-6),(MS-ESS3–5); **HS.ESS3.C** (MS-ESS3–5); **HS.ESS3.D** (MS-ESS3–5)

California Common Core State Standards Connections:
ELA/Literacy –

RST.6–8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-5),(MS-ESS3–5)
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)
WHST.6–8.8	Gather relevant information from multiple print and digital sources **(primary and secondary)**, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. **CA** (MS-ESS2-5)
SL.8.5	Integrate multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS2-6)

Mathematics –

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MP.2	Reason abstractly and quantitatively. (MS-ESS2-5),(MS-ESS3–5)
6.NS.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)
6.EE.6	Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3–5)

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MS Energy

MS Energy

Students who demonstrate understanding can:

6-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.]

6-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.]

6-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.]

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Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that	**PS3.A: Definitions of Energy** ▪ Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a	**Scale, Proportion, and Quantity** ▪ Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about

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use multiple variables and provide evidence to support explanations or design solutions. ▪ Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS3-4) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ▪ Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural	system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4) **PS3.B: Conservation of Energy and Energy Transfer** ▪ When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3–5) ▪ 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) ▪ Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3) **ETS1.A: Defining and Delimiting an Engineering Problem** ▪ 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. (secondary to MS-PS3-3)	the magnitude of properties and processes. (MS-PS3-4) **Energy and Matter** ▪ Energy may take different forms (e.g., energy in fields, thermal energy, energy of motion). (MS-PS3–5) ▪ The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3)

and designed worlds. ▪ Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (MS-PS3–5) **---** ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations (MS-PS3-4),(MS-PS3–5)	**ETS1.B: Developing Possible Solutions** ▪ A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to MS-PS3-3)	
Connections to other DCIs in this grade-band: **MS.PS1.A** (MS-PS3-4); **MS.PS1.B** (MS-PS3-3); **MS.PS2.A** (MS-PS3-4),(MS-PS3–5); **MS.ESS2.A** (MS-PS3-3); **MS.ESS2.C** (MS-PS3-3),(MS-PS3-4); **MS.ESS2.D** (MS-PS3-3),(MS-PS3-4); **MS.ESS3.D** (MS-PS3-4)		
Articulation across grade-bands: **4.PS3.B** (MS-PS3-3); **4.PS3.C** (MS-PS3-4),(MS-PS3–5); **HS.PS1.B** (MS-PS3-4); **HS.PS3.A** (MS-PS3-4),(MS-PS3–5); **HS.PS3.B** (MS-PS3-3),(MS-PS3-4),(MS-PS3–5)		
California 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-PS3–5) **RST.6–8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS3-3),(MS-PS3-4) **WHST.6–8.1.a–e** Write arguments focused on *discipline-specific content*. (MS-PS3–5)		

Grade Six – Integrated Course
Standards Arranged by Topic

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-PS3-4)
Mathematics –	
MP.2	Reason abstractly and quantitatively. (MS-PS3-4),(MS-PS3–5)
6.RP.1	Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3–5)
6.SP.5.a-d	Summarize numerical data sets in relation to their context. (MS-PS3-4)

MS Human Impacts

MS Human Impacts		
Students who demonstrate understanding can: **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).]		
The performance expectations above were developed using the following elements from the NRC document *A Framework for K–12 Science Education*:		
Science and Engineering Practices	**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. ▪ Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3)	**ESS3.C: Human Impacts on Earth Systems** ▪ Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) ▪ Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are	**Cause and Effect** ▪ Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3) --- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ The uses of technologies and limitations on their use are driven by people's needs, desires, and values; by the findings of

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.
**California clarification statements, marked with double asterisks, were incorporated by the California Science Expert Review Panel
The section entitled "Disciplinary Core Ideas" is reproduced verbatim from *A Framework for K–12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas*.

	engineered otherwise. (MS-ESS3-3)	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)

Connections to other DCIs in this grade-band: **MS.LS2.A** (MS-ESS3-3); **MS.LS2.C** (MS-ESS3-3); **MS.LS4.D** (MS-ESS3-3)

Articulation of DCIs across grade-bands: **3.LS2.C** (MS-ESS3-3),(MS-ESS3-4); **3.LS4.D** (MS-ESS3-3),(MS-ESS3-4); **3.ESS3.B** (MS-ESS3-2); **4.ESS3.B** (MS-ESS3-2); **5.ESS3.C** (MS-ESS3-3),(MS-ESS3-4); **HS.LS2.A** (MS-ESS3-4); **HS.LS2.C** (MS-ESS3-3),(MS-ESS3-4); **HS.LS4.C** (MS-ESS3-3),(MS-ESS3-4); **HS.LS4.D** (MS-ESS3-3),(MS-ESS3-4); **HS.ESS2.B** (MS-ESS3-2); **HS.ESS2.C** (MS-ESS3-3); **HS.ESS2.D** (MS-ESS3-2),(MS-ESS3-3); **HS.ESS2.E** (MS-ESS3-3),(MS-ESS3-4); **HS.ESS3.A** (MS-ESS3-4); **HS.ESS3.B** (MS-ESS3-2); **HS.ESS3.C** (MS-ESS3-3),(MS-ESS3-4); **HS.ESS3.D** (MS-ESS3-2),(MS-ESS3-3)

California Common Core State Standards Connections:

ELA/Literacy –

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)

WHST.6–8.8 Gather relevant information from multiple print and digital sources **(primary and secondary)**, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. **CA** (MS-ESS3-3)

Mathematics –

6.RP.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS3-3)

6.EE.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-3)

Grade Six – Integrated Course
Standards Arranged by Topic

MS Engineering Design

MS Engineering Design

Students who demonstrate understanding can:

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

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

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

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

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

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. ▪ Define a design problem that can be solved through the development of an object, tool, process or system and	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)	**Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1) ▪ The uses of technologies and limitations on their use are driven by individual or

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

**California clarification statements, marked with double asterisks, were incorporated by the California Science Expert Review Panel

The section entitled "Disciplinary Core Ideas" is reproduced verbatim from *A Framework for K–12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas*.

includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1) **Developing and Using Models** Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ▪ Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3) **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	**ETS1.B: Developing Possible Solutions** ▪ A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) ▪ There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) ▪ Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) ▪ Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** ▪ Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) ▪ The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test	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)

for either explanations or solutions about the natural and designed world. ▪ Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)	results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	

Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include:
Physical Science: MS-PS3-3
Connections to MS-ETS1.B: Developing Possible Solutions Problems include:
Physical Science: MS-PS1-6, MS-PS3-3, **Life Science:** MS-LS2-5
Connections to MS-ETS1.C: Optimizing the Design Solution include:
Physical Science: MS-PS1-6

Articulation of DCIs across grade-bands: **3–5.ETS1.A** (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3); **3–5.ETS1.B** (MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4); **3–5.ETS1.C** (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4); **HS.ETS1.A** (MS-ETS1-1),(MS-ETS1-2); **HS.ETS1.B** (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4); **HS.ETS1.C** (MS-ETS1-3),(MS-ETS1-4)

California Common Core State Standards Connections:
ELA/Literacy –

RST.6–8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)
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-ETS1-3)
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-ETS1-2),(MS-ETS1-3)
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-ETS1-2)
WHST.6–8.8	Gather relevant information from multiple print and digital sources **(primary and secondary)**, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions

	of others while avoiding plagiarism and following a standard format for citation. **CA** (MS-ETS1-1)
WHST.6–8.9	Draw evidence from informational texts to support analysis, reflection, and research. (MS-ETS1-2)
SL.8.5	Integrate 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-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4)