Next Generation Science Standards (NGSS) combines three dimensions to form each Performance Expectation (Standard).

Practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems.
Crosscutting Concepts have application across all domains of science and are a way of linking the different domains of science. They include: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change.
Disciplinary Core Ideas focus K–12 science curriculum, instruction and assessments on the most important aspects of science. Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science

FIRST® LEGO® League Next Generation Science Standards Alignment & Instructional Exemplars

Rationale	Color Code
There is no evidence that the standard is addressed as part of a *FIRST*® program.	
This standard potentially could be addressed as part of a *FIRST*® program either by actions that the coach/mentor takes when working with the students or by conditions established by the program for that given year.	
The standard is clearly addressed by program activities.	

Title	Standard	Performance Expectation	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts	*FIRST*® Alignment	Instructional Exemplar	Comment
Waves and Their Applications in Technologies for Information Transfer	1-PS4-1	Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.	**Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Plan and conduct investigations collaboratively to produce evidence to answer a question. --- **Connections to Nature of Science** Scientific Investigations Use a Variety of Methods • Science investigations begin with a question. • Scientists use different ways to study the world.	PS4.A: Wave Properties • Sound can make matter vibrate, and vibrating matter can make sound.	**Cause and Effect** • Simple tests can be designed to gather evidence to support or refute student ideas about causes.		Not Applicable	While the *FIRST*® LEGO® League program does not specifically address the Performance Expectation of this standard, throughout the program students engage in investigations to determine robot design and programming which illustrate cause and effect using a variety of methods both of which are key Science and Engineering Practices and Crosscutting Concepts.
Energy	4-PS3-1	Use evidence to construct an explanation relating the speed of an object to the energy of that object.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Use evidence (e.g., measurements, observations, patterns) to construct an explanation.	**PS3.A: Definitions of Energy** • The faster a given object is moving, the more energy it possesses.	**Energy and Matter** • Energy can be transferred in various ways and between objects.		Since the students are working with a moving robot that will be interacting with other objects through touch, they will have the opportunity to develop their thinking around the speed of a moving object and the energy it holds.	
Energy	4-PS3-2	Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	**Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K– 2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	**PS3.A: Definitions of Energy** • Energy can be moved from place to place by moving objects or through sound, light, or electric currents. **PS3.B: Conservation of Energy and Energy Transfer** • Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. • Light also transfers energy from place to place. • Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.	**Energy and Matter** • Energy can be transferred in various ways and between objects.		Students have the opportunity to work with light/color and touch sensors to send information to the robot. They will have the opportunity to explore how energy is transferred using sound, light and electric currents.	
Energy	4-PS3-3	Ask questions and predict outcomes about the changes in energy that occur when objects collide.	**Asking Questions and Defining Problems** Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.	**PS3.A: Definitions of Energy** • Energy can be moved from place to place by moving objects or through sound, light, or electric currents. **PS3.B: Conservation of Energy and Energy Transfer** • Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. **PS3.C: Relationship Between Energy and Forces** • When objects collide, the contact forces transfer energy so as to change the objects' motions.	**Energy and Matter** • Energy can be transferred in various ways and between objects.		Since the students are working with a moving robot that will be interacting with other objects through touch, they will have the opportunity make predictions and to explore how energy changes as the objects collide.	

Energy	4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Apply scientific ideas to solve design problems.	**PS3.B: Conservation of Energy and Energy Transfer** • Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. **PS3.D: Energy in Chemical Processes and Everyday Life** • The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. **ETS1.A: Defining Engineering Problems** • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Energy and Matter** • Energy can be transferred in various ways and between objects. --- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering and Technology on Society and the Natural World** • Engineers improve existing technologies or develop new ones. --- ***Connections to Nature of Science*** **Science is a Human Endeavor** • Most scientists and engineers work in teams. • Science affects everyday life.		As part of the design process and developing game strategy, the students will have to conduct multiple tests on the robot to make sure that when energy conversions occur they are favorable.	
Waves and Their Applications in Technologies for Information Transfer	4-PS4-1	Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.	**Developing and Using Models** Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model using an analogy, example, or abstract representation to describe a scientific principle. --- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science findings are based on recognizing patterns.	**PS4.A: Wave Properties** • Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	**Patterns** • Similarities and differences in patterns can be used to sort and classify natural phenomena.		Not Applicable	While the *FIRST*® LEGO® League program does not specifically address the Performance Expectation of this standard, throughout the program students develop models and look for patterns which are key Science and Engineering Practices and Crosscutting Concepts through construction and programming.
Waves and Their Applications in Technologies for Information Transfer	4-PS4-2	Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.	**Developing and Using Models** Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model to describe phenomena.	**PS4.B: Electromagnetic Radiation** • An object can be seen when light reflected from its surface enters the eyes.	**Cause and Effect** • Cause and effect relationships are routinely identified.		As part of the design and programming process, students may use the light sensor's ability to detect reflected light from the game board for navigation and in the process learn about some properties of reflected light.	
Waves and Their Applications in Technologies for Information Transfer	4-PS4-3	Generate and compare multiple solutions that use patterns to transfer information.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	**PS4.C: Information Technologies and Instrumentation** • Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa. **ETS1.C: Optimizing The Design Solution** • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Knowledge of relevant scientific concepts and research findings is important in engineering.		Not Applicable	While the *FIRST*® LEGO® League program does not specifically address the Performance Expectation of this standard, throughout the program students develop and evaluate multiple solutions to problems to determine the best robot design, program, and strategy illustrating a key Science and Engineering Practice.
From Molecules to Organisms: Structures and Processes	4-LS1-1	Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.	**Engaging in Argument from Evidence** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Construct an argument with evidence, data, and/or a model.	**LS1.A: Structure and Function** • Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.	**Systems and System Models** • A system can be described in terms of its components and their interactions.		Not Applicable	While the *FIRST*® LEGO® League program does not specifically address the Performance Expectation of this standard, throughout the program students construct arguments based on data which analyze and describe how the components of s system function which are a key Science and Engineering Practice and a vital Crosscutting Concept.

From Molecules to Organisms: Structures and Processes	4-LS1-2	Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.	**Developing and Using Models** Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use a model to test interactions concerning the functioning of a natural system.	**LS1.D: Information Processing** • Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.	**Systems and System Models** • A system can be described in terms of its components and their interactions.		Not Applicable	While the *FIRST*® LEGO® League program does not specifically address the Performance Expectation of this standard, throughout the program students use models to analyze and describe how the components of s system function which are a key Science and Engineering Practice and a vital Crosscutting Concept.
Earth's Place in the Universe	4-ESS1-1	Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Identify the evidence that supports particular points in an explanation.	**ESS1.C: The History of Planet Earth** • Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed.	**Patterns** • Patterns can be used as evidence to support an explanation. --- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes consistent patterns in natural systems.		Not Applicable	While the *FIRST*® LEGO® League program does not specifically address the Performance Expectation of this standard, throughout the program students use patterns as evidence to support explanations and make decisions which are a key Science and Engineering Practice and an important Crosscutting Concept.
Earth's Systems	4-ESS2-1	Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.	**Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	**ESS2.A: Earth Materials and Systems** • Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. **ESS2.E: Biogeology** • Living things affect the physical characteristics of their regions.	**Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change.		Not Applicable	While the *FIRST*® LEGO® League program does not specifically address the Performance Expectation of this standard, throughout the program students make observations and measurements to determine cause and effects relationships which are a key Science and Engineering Practice and an important Crosscutting Concept.
Earth's Systems	4-ESS2-2	Analyze and interpret data from maps to describe patterns of Earth's features.	**Analyzing and Interpreting Data** Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Analyze and interpret data to make sense of phenomena using logical reasoning.	**ESS2.B: Plate Tectonics and Large-Scale System Interactions** • The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth.	**Patterns** • Patterns can be used as evidence to support an explanation.		Not Applicable	While the *FIRST*® LEGO® League program does not specifically address the Performance Expectation of this standard, throughout the program students use patterns as evidence to support explanations and make decisions which are a key Science and Engineering Practice and an important Crosscutting Concept.
Earth and Human Activity	4-ESS3-1	Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.	**Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods. • Obtain and combine information from books and other reliable media to explain phenomena.	**ESS3.A: Natural Resources** • Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change. --- ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Knowledge of relevant scientific concepts and research findings is important in engineering. **Influence of Science, Engineering and Technology on Society and the Natural World** • Over time, people's needs and wants change, as do their demands for new and improved technologies.		Not Applicable	While the *FIRST* LEGO® League program does not specifically address the Performance Expectation of this standard, throughout the program students use previously collected data and information to identify cause and effect relationships and improve upon existing technologies to meet new needs which are a key Science and Engineering Practice and an important Crosscutting Concept.

Earth and Human Activity	4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	**ESS3.B: Natural Hazards** • A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. **ETS1.B: Designing Solutions to Engineering Problems** • Testing a solution involves investigating how well it performs under a range of likely conditions.	**Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change. --- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering and Technology on Society and the Natural World** • Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands.		Not Applicable	While the *FIRST*® LEGO® League program does not specifically address the Performance Expectation of this standard, throughout the program students compare and evaluate multiple solutions based on given criteria allowing cause and effect relationships to be identified and technologies to be improved which are a key Science and Engineering Practice and an important Crosscutting Concept.
Engineering Design	3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	**Asking Questions and Defining Problems** Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.	**ETS1.A: Defining and Delimiting Engineering Problems** • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Influence of Engineering, Technology, and Science on Society and the Natural World** • People's needs and wants change over time, as do their demands for new and improved technologies.		The nature of the Challenge provides the conditions for students to make decisions concerning the design of the robot that will be influenced by cost, time, materials, and their determination of overall success.	
Engineering Design	3-5 ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem.	**ETS1.B: Developing Possible Solutions** • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.	**Influence of Engineering, Technology, and Science on Society and the Natural World** • Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.		As an *FIRST*® LEGO® team will have multiple members, students will generate and evaluate multiple different solutions based on established criteria the problems encountered.	
Engineering Design	3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	**Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	**ETS1.B: Developing Possible Solutions** • Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. **ETS1.C: Optimizing the Design Solution** • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.			In an effort to determine the best solution concerning robot design or game strategy, the students will need to design and carry out tests which provide data.	