

**FIRST® Tech Challenge Next Generation Science Standards Alignment & Instructional Exemplars**

**Rationale**

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.

**Color Code**



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

Although FIRST® Tech Challenge may not address a specific standard, it may address one or more dimensions that form the standard. These alignments are noted in the Comment section of the Standards Alignment Map.

Title	Standard	Performance Expectation	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts	FIRST® Alignment	Instructional Exemplar	Comments
Matter and Its Interactions	MS-PS-1-1	Develop models to describe the atomic composition of simple molecules and extended structures.	<p><b>Developing and Using Models</b> 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"> <li>Develop a model to predict and/or describe phenomena.</li> </ul> <p><b>Analyzing and Interpreting Data</b> 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"> <li>Analyze and interpret data to determine similarities and differences in findings.</li> </ul> <p><b>Connections to Nature of Science</b>  <b>Scientific Knowledge is Based on Empirical Evidence</b>                      Science knowledge is based upon logical and conceptual connections between evidence and explanations.  </p>	<p><b>PS1.A: Structure and Properties of Matter</b>                      Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms.</p> <ul style="list-style-type: none"> <li>Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).</li> </ul> <p><b>PS1.A: Structure and Properties of Matter</b>                      Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.</p> <p><b>PS1.B: Chemical Reactions</b>                      Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.</p>	<p><b>Scale, Proportion, and Quantity</b>                      Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.</p> <p><b>Patterns</b>                      Macroscopic patterns are related to the nature of microscopic and atomic-level structure.</p> <p><b>Structure and Function</b>                      Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.</p> <p><b>Connections to Engineering, Technology, and Applications of Science</b>  <b>Interdependence of Science, Engineering, and Technology</b>                      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.</p> <p><b>Influence of Science, Engineering and Technology on Society and the Natural World</b>                      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.</p>	Not Applicable		While the FIRST® Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use models and work with the concept of scale, both of which are key Science and Engineering Practices and Crosscutting Concepts.
Matter and Its Interactions	MS-PS-1-2	Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.	<p><b>Obtaining, Evaluating, and Communicating Information</b> 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"> <li>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.</li> </ul>	<p><b>PS1.A: Structure and Properties of Matter</b>                      Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.</p> <p><b>PS1.B: Chemical Reactions</b>                      Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.</p> <p><b>PS1.A: Structure and Properties of Matter</b>                      Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.</p> <ul style="list-style-type: none"> <li>In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.</li> <li>The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.</li> </ul> <p><b>PS1.A: Structure and Properties of Matter</b>                      The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.</p> <ul style="list-style-type: none"> <li>The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system’s material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system’s total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material.</li> </ul>	<p><b>Patterns</b>                      Macroscopic patterns are related to the nature of microscopic and atomic-level structure.</p> <p><b>Structure and Function</b>                      Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.</p> <p><b>Connections to Engineering, Technology, and Applications of Science</b>  <b>Interdependence of Science, Engineering, and Technology</b>                      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.</p> <p><b>Influence of Science, Engineering and Technology on Society and the Natural World</b>                      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.</p>	Not Applicable		While the FIRST® Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students work with data and use evidence to support explanations, both of which are key Science and Engineering Practices.
Matter and Its Interactions	MS-PS-1-3	Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.	<p><b>Obtaining, Evaluating, and Communicating Information</b> 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"> <li>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.</li> </ul>	<p><b>PS1.A: Structure and Properties of Matter</b>                      Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.</p> <p><b>PS1.B: Chemical Reactions</b>                      Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.</p> <p><b>PS1.A: Structure and Properties of Matter</b>                      Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.</p> <ul style="list-style-type: none"> <li>In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.</li> <li>The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.</li> </ul> <p><b>PS1.A: Structure and Properties of Matter</b>                      The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.</p> <ul style="list-style-type: none"> <li>The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system’s material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system’s total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material.</li> </ul>	<p><b>Patterns</b>                      Macroscopic patterns are related to the nature of microscopic and atomic-level structure.</p> <p><b>Structure and Function</b>                      Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.</p> <p><b>Connections to Engineering, Technology, and Applications of Science</b>  <b>Interdependence of Science, Engineering, and Technology</b>                      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.</p> <p><b>Influence of Science, Engineering and Technology on Society and the Natural World</b>                      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.</p>	Not Applicable		While the FIRST® Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students work with structures to carry out functions, collect and use data from a variety of sources and make improvements to devices, all of which are key Science and Engineering Practices and Crosscutting Concepts.
Matter and Its Interactions	MS-PS-1-4	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	<p><b>Developing and Using Models</b> 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"> <li>Develop a model to predict and/or describe phenomena.</li> </ul>	<p><b>PS1.A: Structure and Properties of Matter</b>                      Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.</p> <p><b>PS1.B: Chemical Reactions</b>                      Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.</p> <p><b>PS1.A: Structure and Properties of Matter</b>                      Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.</p> <ul style="list-style-type: none"> <li>In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.</li> <li>The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.</li> </ul> <p><b>PS1.A: Structure and Properties of Matter</b>                      The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.</p> <ul style="list-style-type: none"> <li>The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system’s material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system’s total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material.</li> </ul>	<p><b>Scale, Proportion, and Quantity</b>                      Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.</p> <p><b>Patterns</b>                      Macroscopic patterns are related to the nature of microscopic and atomic-level structure.</p> <p><b>Structure and Function</b>                      Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.</p> <p><b>Connections to Engineering, Technology, and Applications of Science</b>  <b>Interdependence of Science, Engineering, and Technology</b>                      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.</p> <p><b>Influence of Science, Engineering and Technology on Society and the Natural World</b>                      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.</p>	Not Applicable		While the FIRST® Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students work with physical models and investigate cause and effect relationships, both of which are key Science and Engineering Practices and Crosscutting Concepts.

Matter and Its Interactions	MS-PS-1-5	Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.	<p><b>Developing and Using Models</b> 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"> <li>Develop a model to describe unobservable mechanisms.</li> </ul> <p><b>Science Models, Laws, Mechanisms, and Theories</b> <b>Explain Natural Phenomena</b></p> <ul style="list-style-type: none"> <li>Laws are regularities or mathematical descriptions of natural phenomena.</li> </ul>	<p><b>PS1.B: Chemical Reactions</b> 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"> <li>Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.</li> <li>The total number of each type of atom is conserved, and thus the mass does not change.</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>Matter is conserved because atoms are conserved in physical and chemical processes.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students work with physical models and use mathematics to describe physical events, both of which are key Science and Engineering Practices. Concepts.
Matter and Its Interactions	MS-PS-1-6	Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.	<p><b>Constructing Explanations and Designing Solutions</b> 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.</p> <ul style="list-style-type: none"> <li>Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.</li> </ul>	<p><b>PS1.B: Chemical Reactions</b> Some chemical reactions release energy, others store energy.</p> <p><b>ETS1.B: Developing Possible Solutions</b></p> <ul style="list-style-type: none"> <li>A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.</li> </ul> <p><b>ETS1.C: Optimizing the Design Solution</b></p> <ul style="list-style-type: none"> <li>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 the characteristics may be incorporated into the new design.</li> <li>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.</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>The transfer of energy can be tracked as energy flows through a designed or natural system.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students engage in the design cycle as they refine their robot and its programming which is a key Science and Engineering Practice.
Motion and Stability: Forces and Interactions	MS-PS-2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.	<p><b>Constructing Explanations and Designing Solutions</b> 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"> <li>Apply scientific ideas or principles to design an object, tool, process or system.</li> </ul>	<p><b>PS2.A: Forces and Motion</b></p> <ul style="list-style-type: none"> <li>For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>The transfer of energy can be tracked as energy flows through a designed or natural system.</li> </ul> <p><b>Systems and System Models</b></p> <ul style="list-style-type: none"> <li>Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.</li> <li><b>Connections to Engineering, Technology, and Applications of Science</b></li> </ul> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	Depending upon how the students choose to design their robot, they may take steps to minimize the forces impacting the robot during collisions. Students also determine the force needed to use the robot to move objects.	
Motion and Stability: Forces and Interactions	MS-PS-2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.	<p><b>Planning and Carrying Out Investigations</b> 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"> <li>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.</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations.</li> </ul>	<p><b>PS2.A: Forces and Motion</b></p> <ul style="list-style-type: none"> <li>The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.</li> <li>All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.</li> </ul>	<p><b>Stability and Change</b></p> <ul style="list-style-type: none"> <li>Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.</li> </ul>	As the program involves a moving robot interacting with stationary objects, students will have the opportunity to investigate the role forces and mass play in changing an object's motion in an effort to design both the best robot as well as best strategy.	
Motion and Stability: Forces and Interactions	MS-PS-2-3	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.	<p><b>Asking Questions and Defining Problems</b> Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.</p> <ul style="list-style-type: none"> <li>Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.</li> </ul>	<p><b>PS2.B: Types of Interactions</b></p> <ul style="list-style-type: none"> <li>Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.</li> </ul>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Cause and effect relationships may be used to predict phenomena in natural or designed systems.</li> </ul>	Static is a significant factor in some region's competitions. Teams in these areas must be prepared for and address how static will affect their robot's performance which may include adjusting the robot design and/or using materials to mitigate static.	
Motion and Stability: Forces and Interactions	MS-PS-2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.	<p><b>Engaging in Argument from Evidence</b> Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.</p> <ul style="list-style-type: none"> <li>Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.</li> </ul>	<p><b>PS2.B: Types of Interactions</b></p> <ul style="list-style-type: none"> <li>Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)</li> </ul>	<p><b>Systems and System Models</b></p> <ul style="list-style-type: none"> <li>Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use evidence from models to create oral and written arguments which are key Science and Engineering Practices and Crosscutting Concept.
Motion and Stability: Forces and Interactions	MS-PS-2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.	<p><b>Planning and Carrying Out Investigations</b> 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"> <li>Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.</li> </ul>	<p><b>PS2.B: Types of Interactions</b></p> <ul style="list-style-type: none"> <li>Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively).</li> </ul>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Cause and effect relationships may be used to predict phenomena in natural or designed systems.</li> </ul>	Static is a significant factor in some region's competitions. Teams in these areas must be prepared for and address how static will affect their robot's performance which may include adjusting the robot design and/or using materials to mitigate static.	
Energy	MS-PS-3-1	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.	<p><b>Analyzing and Interpreting Data</b> 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"> <li>Construct and interpret graphical displays of data to identify linear and nonlinear relationships.</li> </ul>	<p><b>PS3.A: Definitions of Energy</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p><b>Scale, Proportion, and Quantity</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	As the program involves a moving robot interacting with stationary objects, students will have the opportunity to collect and display data related to the kinetic energy of the robot in an effort to program the most appropriate interaction with an object.	

Energy	MS-PS3-2	Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.	<p><b>Developing and Using Models</b> 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"> <li>Develop a model to describe unobservable mechanisms.</li> </ul>	<p><b>PS3.A: Definitions of Energy</b></p> <ul style="list-style-type: none"> <li>A system of objects may also contain stored (potential) energy, depending on their relative positions.</li> </ul> <p><b>PS3.C: Relationship Between Energy and Forces</b></p> <ul style="list-style-type: none"> <li>When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.</li> </ul> <p><b>PS3.A: Definitions of Energy</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul> <p><b>PS3.B: Conservation of Energy and Energy Transfer</b></p> <ul style="list-style-type: none"> <li>Energy is spontaneously transferred out of hotter regions or objects and into cooler ones.</li> </ul> <p><b>ETS1.A: Defining and Delimiting an Engineering Problem</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p><b>Systems and System Models</b></p> <ul style="list-style-type: none"> <li>Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.</li> </ul>	<p>Static is a significant factor in some region's competitions. Teams in these areas must be prepared for and address how static will affect their robot's performance which may include adjusting the robot design and/or using materials to mitigate static.</p>	
Energy	MS-PS3-3	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.	<p><b>Constructing Explanations and Designing Solutions</b> 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"> <li>Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system.</li> </ul>	<p><b>PS3.A: Definitions of Energy</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul> <p><b>PS3.B: Conservation of Energy and Energy Transfer</b></p> <ul style="list-style-type: none"> <li>Energy is spontaneously transferred out of hotter regions or objects and into cooler ones.</li> </ul> <p><b>ETS1.A: Defining and Delimiting an Engineering Problem</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>The transfer of energy can be tracked as energy flows through a designed or natural system.</li> </ul>	<p>Not Applicable</p>	<p>While the <i>FIRST</i><sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students apply scientific knowledge to design their robot and its programming which is a key Science and Engineering Practice.</p>
Energy	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.	<p><b>Planning and Carrying Out Investigations</b> 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"> <li>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.</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations.</li> </ul> <p><b>engaging in argument from evidence</b> 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"> <li>Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute.</li> </ul> <p><b>Using Mathematics and Computational Thinking</b> 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"> <li>Use mathematical representations to describe and/or support scientific conclusions and design solutions.</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations.</li> </ul>	<p><b>PS3.A: Definitions of Energy</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul> <p><b>PS3.B: Conservation of Energy and Energy Transfer</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p><b>Scale, Proportion, and Quantity</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p>Not Applicable</p>	<p>While the <i>FIRST</i><sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use collected data and information to understand proportional relationships which are key Science and Engineering Practice and an important Crosscutting Concept.</p>
Energy	MS-PS3-5	Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.	<p><b>engaging in argument from evidence</b> 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"> <li>Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute.</li> </ul> <p><b>Using Mathematics and Computational Thinking</b> 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"> <li>Use mathematical representations to describe and/or support scientific conclusions and design solutions.</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations.</li> </ul>	<p><b>PS3.B: Conservation of Energy and Energy Transfer</b></p> <ul style="list-style-type: none"> <li>When the motion energy of an object changes, there is inevitably some other change in energy at the same time.</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).</li> </ul>	<p>Since challenges require a moving robot to interact with stationary objects, other moving objects and/or flying objects, students will have the opportunity to explore how kinetic energy changes when the robot and the object interact.</p>	
Waves and Their Applications in Technologies for Information Transfer	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.	<p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations.</li> </ul>	<p><b>PS4.A: Wave Properties</b></p> <ul style="list-style-type: none"> <li>A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>Graphs and charts can be used to identify patterns in data.</li> </ul>	<p>Not Applicable</p>	<p>While the <i>FIRST</i><sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students construct graphs of collected data in order to analyze information and create conclusions which are key Science and Engineering Practice and an important Crosscutting Concept.</p>
Waves and Their Applications in Technologies for Information Transfer	MS-PS4-2	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.	<p><b>Developing and Using Models</b> 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"> <li>Develop and use a model to describe phenomena.</li> </ul>	<p><b>PS4.A: Wave Properties</b></p> <ul style="list-style-type: none"> <li>A sound wave needs a medium through which it is transmitted.</li> </ul> <p><b>PS4.B: Electromagnetic Radiation</b></p> <ul style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media.</li> <li>However, because light can travel through space, it cannot be a matter wave, like sound or water waves.</li> </ul>	<p><b>Structure and Function</b></p> <ul style="list-style-type: none"> <li>Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.</li> </ul>	<p>Radio waves used in the control of the robots may be affected by environmental conditions. Students need to understand how these conditions affect the control of the robot and what they can do to alleviate problems.</p>	
Waves and Their Applications in Technologies for Information Transfer	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.	<p><b>Obtaining, Evaluating, and Communicating Information</b> 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"> <li>Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.</li> </ul>	<p><b>PS4.C: Information Technologies and Instrumentation</b></p> <ul style="list-style-type: none"> <li>Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.</li> </ul>	<p><b>Structure and Function</b></p> <ul style="list-style-type: none"> <li>Structures can be designed to serve particular functions.</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Science is a Human Endeavor</b></p> <ul style="list-style-type: none"> <li>Advances in technology influence the progress of science and science has influenced advances in technology.</li> </ul>	<p>Not Applicable</p>	<p>While the <i>FIRST</i><sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students write research papers that incorporate scientific and technical information which are key Science and Engineering Practice and an important Crosscutting Concept.</p>

From Molecules to Organisms: Structures and Processes	MS-LS-1-1	Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.	<p><b>Planning and Carrying Out Investigations</b></p> <p>Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.</p> <ul style="list-style-type: none"> <li>Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.</li> </ul>	<p><b>LS1.A: Structure and Function</b></p> <ul style="list-style-type: none"> <li>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).</li> </ul>	<p><b>Scale, Proportion, and Quantity</b></p> <ul style="list-style-type: none"> <li>Phenomena that can be observed at one scale may not be observable at another scale.</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Interdependence of Science, Engineering, and Technology</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students collect data to understand proportional relationships which are key Science and Engineering Practice and an important Crosscutting Concept.
From Molecules to Organisms: Structures and Processes	MS-LS-1-2	Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.	<p><b>Developing and Using Models</b></p> <p>Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> <li>Develop and use a model to describe phenomena.</li> </ul>	<p><b>LS1.A: Structure and Function</b></p> <ul style="list-style-type: none"> <li>Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.</li> </ul>	<p><b>Structure and Function</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students work with physical models to understand real-world situations.
From Molecules to Organisms: Structures and Processes	MS-LS-1-3	Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	<p><b>Engaging in Argument from Evidence</b></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"> <li>Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon.</li> </ul>	<p><b>LS1.A: Structure and Function</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p><b>Systems and System Models</b></p> <ul style="list-style-type: none"> <li>Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Science is a Human Endeavor</b></p> <ul style="list-style-type: none"> <li>Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use collected data and information to understand proportional relationships which are key Science and Engineering Practice and an important Crosscutting Concept.
From Molecules to Organisms: Structures and Processes	MS-LS-1-4	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.	<p><b>Engaging in Argument from Evidence</b></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"> <li>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.</li> </ul> <p><b>Constructing Explanations and Designing Solutions</b></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 knowledge, principles, and theories.</p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p><b>LS1.B: Growth and Development of Organisms</b></p> <ul style="list-style-type: none"> <li>Animals engage in characteristic behaviors that increase the odds of reproduction.</li> <li>Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.</li> </ul>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students make oral and written presentations about the cause and effect of different phenomena which are key Science and Engineering Practice and an important Crosscutting Concept.
From Molecules to Organisms: Structures and Processes	MS-LS-1-5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	<p><b>Constructing Explanations and Designing Solutions</b></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 knowledge, principles, and theories.</p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p><b>LS1.B: Growth and Development of Organisms</b></p> <ul style="list-style-type: none"> <li>Genetic factors as well as local conditions affect the growth of the adult plant.</li> </ul>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students conduct investigations about the cause and effect of different phenomena which are key Science and Engineering Practice and an important Crosscutting Concept.
From Molecules to Organisms: Structures and Processes	MS-LS-1-6	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.	<p><b>Constructing Explanations and Designing Solutions</b></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 knowledge, principles, and theories.</p> <ul style="list-style-type: none"> <li>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.</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical connections between evidence and explanations.</li> </ul>	<p><b>LS1.C: Organization for Matter and Energy Flow in Organisms</b></p> <ul style="list-style-type: none"> <li>Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.</li> </ul> <p><b>PS3.D: Energy in Chemical Processes and Everyday Life</b></p> <ul style="list-style-type: none"> <li>The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen.</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>Within a natural system, the transfer of energy drives the motion and/or cycling of matter.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students construct conclusions from evidence which is a key Science and Engineering Practice.
From Molecules to Organisms: Structures and Processes	MS-LS-1-7	Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.	<p><b>Developing and Using Models</b></p> <p>Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> <li>Develop a model to describe unobservable mechanisms.</li> </ul>	<p><b>LS1.C: Organization for Matter and Energy Flow in Organisms</b></p> <ul style="list-style-type: none"> <li>Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy.</li> </ul> <p><b>PS3.D: Energy in Chemical Processes and Everyday Life</b></p> <ul style="list-style-type: none"> <li>Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials.</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>Matter is conserved because atoms are conserved in physical and chemical processes.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students work with physical and mathematical models which is a key Science and Engineering Practice.
From Molecules to Organisms: Structures and Processes	MS-LS-1-8	Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.	<p><b>Obtaining, Evaluating, and Communicating Information</b></p> <p>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"> <li>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.</li> </ul>	<p><b>LS1.D: Information Processing</b></p> <ul style="list-style-type: none"> <li>Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting 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.</li> </ul>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Cause and effect relationships may be used to predict phenomena in natural systems.</li> </ul>	Not Applicable	During the autonomous period of game play, robots use sensors to gather information about the environment in much the same way sensory receptors gather information. Information gathered by the sensors send messages to the robot to respond in a predetermined pattern.

Ecosystems: Interactions, Energy, and Dynamics	MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.	<p><b>Analyzing and Interpreting Data</b> 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"> <li>Analyze and interpret data to provide evidence for phenomena.</li> </ul>	<p><b>LS2.A: Interdependent Relationships in Ecosystems</b></p> <ul style="list-style-type: none"> <li>Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.</li> <li>In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.</li> <li>Growth of organisms and population increases are limited by access to resources.</li> </ul>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Cause and effect relationships may be used to predict phenomena in natural or designed systems.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students analyze and interpret data to understand cause and effect relationships which are key Science and Engineering Practice and an important Crosscutting Concept.
Ecosystems: Interactions, Energy, and Dynamics	MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	<p><b>Constructing Explanations and Designing Solutions</b> 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"> <li>Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.</li> </ul>	<p><b>LS2.A: Interdependent Relationships in Ecosystems</b></p> <ul style="list-style-type: none"> <li>Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>Patterns can be used to identify cause and effect relationships.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students construct explanations that include data to identify and describe patterns which are key Science and Engineering Practice and an important Crosscutting Concept.
Ecosystems: Interactions, Energy, and Dynamics	MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	<p><b>Developing and Using Models</b> Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> <li>Develop a model to describe phenomena.</li> </ul>	<p><b>LS2.B: Cycle of Matter and Energy Transfer in Ecosystems</b></p> <ul style="list-style-type: none"> <li>Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>The transfer of energy can be tracked as energy flows through a natural system.</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b></p> <ul style="list-style-type: none"> <li>Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students develop models to describe events which is a key Science and Engineering Practice.
Ecosystems: Interactions, Energy, and Dynamics	MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	<p><b>Engaging in Argument from Evidence</b> 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"> <li>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.</li> </ul> <p><b>Connections to Nature of Science</b> <b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science disciplines share common rules of obtaining and evaluating empirical evidence.</li> </ul>	<p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b></p> <ul style="list-style-type: none"> <li>Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.</li> </ul>	<p><b>Stability and Change</b></p> <ul style="list-style-type: none"> <li>Small changes in one part of a system might cause large changes in another part.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students follow rules to evaluate information that they include in oral and written presentations which is a key Science and Engineering Practice.
Ecosystems: Interactions, Energy, and Dynamics	MS-LS2-5	Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	<p><b>Engaging in Argument from Evidence</b> 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"> <li>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.</li> <li>Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.</li> </ul>	<p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b></p> <ul style="list-style-type: none"> <li>Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.</li> </ul> <p><b>LS4.D: Biodiversity and Humans</b></p> <ul style="list-style-type: none"> <li>Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.</li> </ul> <p><b>ETS1.B: Developing Possible Solutions</b></p> <ul style="list-style-type: none"> <li>There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.</li> </ul>	<p><b>Stability and Change</b></p> <ul style="list-style-type: none"> <li>Small changes in one part of a system might cause large changes in another part.</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students make oral arguments to explain their design ideas and why changes to the system would be beneficial which are key Science and Engineering Practice and an important Crosscutting Concept.
Heredity: Inheritance and Variation of Traits	MS-LS3-1	Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.	<p><b>Developing and Using Models</b> Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> <li>Develop and use a model to describe phenomena.</li> </ul>	<p><b>LS3.A: Inheritance of Traits</b></p> <ul style="list-style-type: none"> <li>Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.</li> </ul> <p><b>LS3.B: Variation of Traits</b></p> <ul style="list-style-type: none"> <li>In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.</li> </ul>	<p><b>Structure and Function</b></p> <ul style="list-style-type: none"> <li>Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students work with models which is a key Science and Engineering Practice.
Heredity: Inheritance and Variation of Traits	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.	<p><b>Developing and Using Models</b> Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> <li>Develop and use a model to describe phenomena.</li> </ul>	<p><b>LS1.B: Growth and Development of Organisms</b></p> <ul style="list-style-type: none"> <li>Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.</li> </ul> <p><b>LS3.A: Inheritance of Traits</b></p> <ul style="list-style-type: none"> <li>Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.</li> </ul> <p><b>LS3.B: Variation of Traits</b></p> <ul style="list-style-type: none"> <li>In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. 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.</li> </ul>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Cause and effect relationships may be used to predict phenomena in natural systems.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students work with models to help them understand cause and effect relationships which is a key Science and Engineering Practice and Crosscutting Concept.

Biological Evolution: Unity and Diversity	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.	<p><b>Analyzing and Interpreting Data</b> 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> <p>• Analyze and interpret data to determine similarities and differences in findings.</p> <p>-----</p> <p><b>Connections to Nature of Science</b> <b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>• Science knowledge is based upon logical and conceptual connections between evidence and explanations.</li> </ul>	<p><b>LS4.A: Evidence of Common Ancestry and Diversity</b></p> <ul style="list-style-type: none"> <li>• 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.</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>• Graphs, charts, and images can be used to identify patterns in data.</li> </ul> <p>-----</p> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b></p> <ul style="list-style-type: none"> <li>• Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students analyze data using charts and graphs to make conclusions which are key Science and Engineering Practice and an important Crosscutting Concept.
Biological Evolution: Unity and Diversity	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.	<p><b>Constructing Explanations and Designing Solutions</b> 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"> <li>• Apply scientific ideas to construct an explanation for realworld phenomena, examples, or events.</li> </ul>	<p><b>LS4.A: Evidence of Common Ancestry and Diversity</b></p> <ul style="list-style-type: none"> <li>• 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.</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>• Patterns can be used to identify cause and effect relationships.</li> </ul> <p>-----</p> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b></p> <ul style="list-style-type: none"> <li>• Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students apply scientific ideas to construct an explanation for observed patterns which are key Science and Engineering Practice and an important Crosscutting Concept.
Biological Evolution: Unity and Diversity	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.	<p><b>Analyzing and Interpreting Data</b> 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"> <li>• Analyze displays of data to identify linear and nonlinear relationships.</li> </ul>	<p><b>LS4.A: Evidence of Common Ancestry and Diversity</b></p> <ul style="list-style-type: none"> <li>• Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy.</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>• Graphs, charts, and images can be used to identify patterns in data.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students analyze data using charts and graphs to make conclusions which are key Science and Engineering Practice and an important Crosscutting Concept.
Biological Evolution: Unity and Diversity	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.	<p><b>Constructing Explanations and Designing Solutions</b> 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"> <li>• Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena.</li> </ul>	<p><b>LS4.B: Natural Selection</b></p> <ul style="list-style-type: none"> <li>• Natural selection leads to the predominance of certain traits in a population, and the suppression of others.</li> </ul>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>• Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use collected data and information to understand cause and effect relationships which are key Science and Engineering Practice and an important Crosscutting Concept.
Biological Evolution: Unity and Diversity	MS-LS4-5	Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.	<p><b>Obtaining, Evaluating, and Communicating Information</b> 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"> <li>• 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.</li> </ul>	<p><b>LS4.B: Natural Selection</b></p> <ul style="list-style-type: none"> <li>• In artificial 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.</li> </ul>	<p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Interdependence of Science, Engineering, and Technology</b></p> <ul style="list-style-type: none"> <li>• 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.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students analyze data using charts and graphs to make conclusions which are key Science and Engineering Practice and an important Crosscutting Concept.
Biological Evolution: Unity and Diversity	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.	<p><b>Using Mathematics and Computational Thinking</b> 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.</p> <ul style="list-style-type: none"> <li>• Use mathematical representations to support scientific conclusions and design solutions.</li> </ul>	<p><b>LS4.C: Adaptation</b></p> <ul style="list-style-type: none"> <li>• 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.</li> </ul>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>• Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use mathematical models to understand phenomena which are key Science and Engineering Practice and an important Crosscutting Concept.
Earth's Place in the Universe	MS-ESS1-1	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.	<p><b>Developing and Using Models</b> Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> <li>• Develop and use a model to describe phenomena.</li> </ul>	<p><b>ESS1.A: The Universe and Its Stars</b></p> <ul style="list-style-type: none"> <li>• Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.</li> </ul> <p><b>ESS1.B: Earth and the Solar System</b></p> <ul style="list-style-type: none"> <li>• This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>• Patterns can be used to identify cause and-effect relationships.</li> </ul> <p>-----</p> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b></p> <ul style="list-style-type: none"> <li>• Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use mathematical models to understand phenomena which are key Science and Engineering Practice and an important Crosscutting Concept.
Earth's Place in the Universe	MS-ESS1-2	Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.	<p><b>Developing and Using Models</b> Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> <li>• Develop and use a model to describe phenomena.</li> </ul>	<p><b>ESS1.A: The Universe and Its Stars</b></p> <ul style="list-style-type: none"> <li>• Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.</li> </ul> <p><b>ESS1.B: Earth and the Solar System</b></p> <ul style="list-style-type: none"> <li>• The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.</li> <li>• The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.</li> </ul>	<p><b>Systems and System Models</b></p> <ul style="list-style-type: none"> <li>• Models can be used to represent systems and their interactions.</li> </ul> <p>-----</p> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b></p> <ul style="list-style-type: none"> <li>• Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use mathematical models to understand phenomena which are key Science and Engineering Practice and an important Crosscutting Concept.

Earth's Place in the Universe	MS-ESS1-3	Analyze and interpret data to determine scale properties of objects in the solar system.	<p><b>Analyzing and Interpreting Data</b> 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"> <li>Analyze and interpret data to determine similarities and differences in findings.</li> </ul>	<p><b>ESS1.B: Earth and the Solar System</b></p> <ul style="list-style-type: none"> <li>The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.</li> </ul>	<p><b>Interdependence of Science, Engineering, and Technology</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students compare and contrast different data to make decisions which is a key Science and Engineering Practice.
Earth's Place in the Universe	MS-ESS1-4	Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.	<p><b>Constructing Explanations and Designing Solutions</b> 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"> <li>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.</li> </ul>	<p><b>ESS1.C: The History of Planet Earth</b></p> <ul style="list-style-type: none"> <li>The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale.</li> </ul>	<p><b>Scale, Proportion, and Quantity</b></p> <ul style="list-style-type: none"> <li>Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use collected data and information to understand proportional relationships which is a key Science and Engineering Practice.
Earth's Systems	MS-ESS2-1	Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.	<p><b>Developing and Using Models</b> Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> <li>Develop and use a model to describe phenomena.</li> </ul>	<p><b>ESS2.A: Earth's Materials and Systems</b></p> <ul style="list-style-type: none"> <li>All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.</li> </ul>	<p><b>Stability and Change</b></p> <ul style="list-style-type: none"> <li>Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students work with physical and mathematical models to understand phenomena which is a key Science and Engineering Practice.
Earth's Systems	MS-ESS2-2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.	<p><b>Constructing Explanations and Designing Solutions</b> 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"> <li>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 nature operate today as they did in the past and will continue to do so in the future.</li> </ul>	<p><b>ESS2.A: Earth's Materials and System</b></p> <ul style="list-style-type: none"> <li>The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future.</li> </ul> <p><b>ESS2.C: The Roles of Water in Earth's Surface Processes</b></p> <ul style="list-style-type: none"> <li>Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.</li> </ul>	<p><b>Scale Proportion and Quantity</b></p> <ul style="list-style-type: none"> <li>Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students work with physical and mathematical models to understand phenomena which is a key Science and Engineering Practice and an important Crosscutting Concept.
Earth's Systems	MS-ESS2-3	Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.	<p><b>Analyzing and Interpreting Data</b> 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"> <li>Analyze and interpret data to provide evidence for phenomena.</li> </ul> <p><b>Connections to Nature of Science</b> <b>Scientific Knowledge is Open to Revision in Light of New Evidence</b></p> <ul style="list-style-type: none"> <li>Science findings are frequently revised and/or reinterpreted based on new evidence.</li> </ul>	<p><b>ESS1.C: The History of Planet Earth</b></p> <ul style="list-style-type: none"> <li>Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches.</li> </ul> <p><b>ESS2.B: Plate Tectonics and Large-Scale System Interactions</b></p> <ul style="list-style-type: none"> <li>Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart.</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>Patterns in rates of change and other numerical relationships can provide information about natural systems.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use collected data and information to understand patterns which are key Science and Engineering Practice and an important Crosscutting Concept.
Earth's Systems	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.	<p><b>Developing and Using Models</b> Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> <li>Develop a model to describe unobservable mechanisms.</li> </ul>	<p><b>ESS2.C: The Roles of Water in Earth's Surface Processes</b></p> <ul style="list-style-type: none"> <li>Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.</li> <li>Global movements of water and its changes in form are propelled by sunlight and gravity.</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use physical and mathematical models to understand phenomena which is a key Science and Engineering Practice.
Earth's Systems	MS-ESS2-5	Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.	<p><b>Planning and Carrying Out Investigations</b> Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.</p> <ul style="list-style-type: none"> <li>Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.</li> </ul>	<p><b>ESS2.C: The Roles of Water in Earth's Surface Processes</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul> <p><b>ESS2.D: Weather and Climate</b></p> <ul style="list-style-type: none"> <li>Because these patterns are so complex, weather can only be predicted probabilistically.</li> </ul>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Cause and effect relationships may be used to predict phenomena in natural or designed systems.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use collected data and information to understand proportional relationships which are key Science and Engineering Practice and an important Crosscutting Concept.
Earth's Systems	MS-ESS2-6	Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.	<p><b>Developing and Using Models</b> Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> <li>Develop and use a model to describe phenomena.</li> </ul>	<p><b>ESS2.C: The Roles of Water in Earth's Surface Processes</b></p> <ul style="list-style-type: none"> <li>Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.</li> </ul> <p><b>ESS2.D: Weather and Climate</b></p> <ul style="list-style-type: none"> <li>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.</li> <li>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.</li> </ul>	<p><b>Systems and System Models</b></p> <ul style="list-style-type: none"> <li>Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.</li> </ul>	Not Applicable	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use physical and mathematical models to understand systems and interactions which are key Science and Engineering Practice and an important Crosscutting Concept.

Earth and Human Activity	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.	<p><b>Constructing Explanations and Designing Solutions</b> 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"> <li>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.</li> </ul>	<p><b>ESS3.A: Natural Resources</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	Not Applicable	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Cause and effect relationships may be used to predict phenomena in natural or designed systems.</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul> <p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>Graphs, charts, and images can be used to identify patterns in data.</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p>	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students use collected data and information to construct explanations of cause and effect relationships which are key Science and Engineering Practice and an important Crosscutting Concept.
Earth and Human Activity	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.	<p><b>Analyzing and Interpreting Data</b> 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"> <li>Analyze and interpret data to determine similarities and differences in findings.</li> </ul>	<p><b>ESS3.B: Natural Hazards</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	Not Applicable	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Relationships can be classified as causal or correlation, and correlation does not necessarily imply causation.</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students analyze graphs and charts of collected data to understand patterns which are key Science and Engineering Practice and an important Crosscutting Concept.
Earth and Human Activity	MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	<p><b>Constructing Explanations and Designing Solutions</b> 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"> <li>Apply scientific principles to design an object, tool, process or system.</li> </ul>	<p><b>ESS3.C: Human Impacts on Earth Systems</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	Not Applicable	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Cause and effect relationships may be used to predict phenomena in natural or designed systems.</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students design a robot to interact with a variety of objects and produce a series of events which are key Science and Engineering Practice and an important Crosscutting Concept.
Earth and Human Activity	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.	<p><b>Engaging in Argument from Evidence</b> 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"> <li>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.</li> </ul>	<p><b>ESS3.D: Human Impacts on Earth Systems</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	Not Applicable	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Cause and effect relationships may be used to predict phenomena in natural or designed systems.</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Science Addresses Questions About the Natural and Material World</b></p> <ul style="list-style-type: none"> <li>Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.</li> </ul>	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students will make oral and written arguments that describe phenomena and offer alternative actions which are key Science and Engineering Practice and an important Crosscutting Concept.
Earth and Human Activity	MS-ESS3-5	Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.	<p><b>Asking Questions and Defining Problems</b> 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.</p> <ul style="list-style-type: none"> <li>Ask questions to identify and clarify evidence of an argument.</li> </ul>	<p><b>ESS3.D: Global Climate Change</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	Not Applicable	<p><b>Stability and Change</b></p> <ul style="list-style-type: none"> <li>Stability might be disturbed either by sudden events or gradual changes that accumulate over time.</li> </ul>	While the <i>FIRST</i> <sup>®</sup> Tech Challenge program does not specifically address the Performance Expectation of this standard, throughout the program students ask questions and clarify evidence which is a key Science and Engineering Practice.
Engineering Design	MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	<p><b>Asking Questions and Defining Problems</b> 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.</p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p><b>ETS1.A: Defining and Delimiting Engineering Problems</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	In order to develop a robot and a successful strategy to the game, students will need to address the constraints imposed by the materials, game challenges, game layout, and programming options, as well as the definitions of success established by the game when designing, building, and programming their robot.		

Engineering Design	MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	<p><b>Engaging in Argument from Evidence</b></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.</p> <ul style="list-style-type: none"> <li>Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.</li> </ul>	<p><b>ETS1.B: Developing Possible Solutions</b></p> <ul style="list-style-type: none"> <li>There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.</li> </ul>	<p>As there are multiple members of a FTC team, students will need to conduct systematic tests to select both designs and programming options that meet the criteria and constraints of the game.</p>
Engineering Design	MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	<p><b>Analyzing and Interpreting Data</b></p> <p>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"> <li>Analyze and interpret data to determine similarities and differences in findings.</li> </ul>	<p><b>ETS1.B: Developing Possible Solutions</b></p> <ul style="list-style-type: none"> <li>There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.</li> <li>Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.</li> </ul> <p><b>ETS1.C: Optimizing the Design Solution</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p>Students will analyze data from tests to determine the designs and programming options that best meet the criteria and constraints of the game.</p>
Engineering Design	MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	<p><b>Developing and Using Models</b></p> <p>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> <li>Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.</li> </ul>	<p><b>ETS1.B: Developing Possible Solutions</b></p> <ul style="list-style-type: none"> <li>A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.</li> <li>Models of all kinds are important for testing solutions.</li> </ul> <p><b>ETS1.C: Optimizing the Design Solution</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p>Since robot design and programming are not static, students will have the opportunity to conduct multiple iterative tests to insure that their final solution is the best possible given criteria and constraints.</p>