Proficiency Level Descriptors

Grade 5

Policy PLDs

Policy PLDs define the knowledge and skill level expectations for all grades and content areas.

Level 4

Students demonstrate evidence of **thorough** understanding and use of college and career readiness knowledge, skills, and abilities.

Level 3

Students demonstrate evidence of **satisfactory** understanding and use of college and career readiness knowledge, skills, and abilities.

Level 2

Students demonstrate evidence of **partial** understanding and use of college and career readiness knowledge, skills, and abilities.

Level 1

Students demonstrate evidence of **emerging** understanding and use of college and career readiness knowledge, skills, and abilities.

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Range PLDs

Range PLDs describe the knowledge and skills that students throughout the range of each proficiency level are expected to be able to demonstrate. In line with the nature of the science standards, the statements combine science and engineering practices, disciplinary core ideas, and crosscutting concepts that students are expected to integrate and demonstrate.

Level 4

Students at **Level 4** demonstrate evidence of thorough understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences. In addition to demonstrating the skills and understandings at Level 3, students performing at Level 4 can be expected to be able to demonstrate knowledge and skills like in the following examples, as evidence of thorough understanding and use of the science standards:

- Develop, use, and analyze a model to describe and explain phenomena using an understanding of matter as tiny particles, describe quantities that should be measured to explain phenomena using an understanding of conservation of matter during physical and chemical changes, describe observations and measurements that can be used to identify materials based on their properties, and plan and conduct an investigation to determine whether a new substance with different properties is formed when two substances are mixed. (PS1)
- Plan and conduct an investigation to provide multiple pieces of evidence about phenomena using an understanding of the effects of balanced and unbalanced forces on the motion of an object, predict the future motion of an object based on complex patterns in observations and measurements, ask detailed questions to describe phenomena using an understanding of cause and effect of electric and magnetic interactions between objects not in contact with each other, thoroughly define a simple design problem that can be solved using magnets, and support an argument with multiple pieces of evidence about phenomena using an understanding that the gravitational force of Earth on objects is directed down. (PS2)
- Construct an explanation supported by multiple pieces of evidence about phenomena using an understanding of the relationship between the speed and energy of an object; provide and analyze evidence that energy can be transferred from place to place; predict and explain outcomes for the changes in energy that occur when objects collide; thoroughly design, test, and refine a device that converts energy from one form to another; and use models to explain phenomena using an understanding that food energy was once energy from the Sun. (PS3)
- Develop models to explain phenomena using an understanding that waves can cause objects to move and that light allows objects to be seen; and compare and explain multiple solutions that use patterns to transfer information. (PS4)
- Develop models to explain phenomena using an understanding of the diversity and commonalities of the life cycles of organisms, construct an argument supported by multiple pieces of evidence about phenomena using an understanding that plants and animals have

internal and external structures that support life functions, explain phenomena using an understanding that animals receive, process, and respond to information from their senses, and support an argument with multiple pieces of evidence about phenomena using an understanding that plants get the materials they need for growth chiefly from air and water. (LS1)

- Construct an argument supported by multiple pieces of evidence about phenomena using an understanding that some animals form groups that help members survive; and develop a model to explain phenomena using an understanding of the movement of matter among plants, animals, decomposers, and the environment. (LS2)
- Analyze and interpret data to provide multiple pieces of evidence about phenomena using an understanding that plants and animals have inherited traits and that variation of these traits exists in groups of similar organisms; and support an explanation with multiple pieces of evidence about phenomena using an understanding that traits can be influenced by the environment. (LS3)
- Analyze and interpret fossil data to provide multiple pieces of evidence of organisms and the environments in which they lived; construct an explanation supported by multiple pieces of evidence of phenomena using an understanding that variation among individuals of the same species is a survival advantage and that in a particular habitat some organisms survive well, some survive less well, and some cannot survive at all; and make a claim supported by multiple pieces of evidence about the merit of a solution to a problem caused by changes to the environment and the types of plants and animals that live there. (LS4)
- Explain phenomena using an understanding that patterns in rock formations and fossils in rock layers provide evidence to support an explanation for changes in a landscape over time, support an argument about phenomena using multiple pieces of evidence and an understanding that differences in the apparent brightness of the Sun compared to other stars is due to their relative distances from Earth, and represent and explain data in graphical displays to reveal patterns of daily changes in shadows, day and night, and the seasonal appearance of stars. (ESS1)
- Represent data to explain typical seasonal weather conditions, combine and synthesize information to describe climates in different regions of the world, provide multiple pieces of evidence for phenomena using an understanding of the effects of weathering and the rate of erosion, analyze and interpret data from maps to explain patterns of Earth's features, develop a model to explain phenomena using an understanding of how multiple systems on Earth interact, and describe and graph the percentages of water to provide multiple pieces of evidence about the distribution of water on Earth. (ESS2)
- Make a claim supported by multiple pieces of evidence about the merit of a design solution that reduces the impacts of a weather-related hazard, combine and synthesize information to explain that energy and fuels are derived from natural resources, how their uses affect the environment, and ways individual communities protect Earth's resources and the environment, and generate and compare multiple solutions to reduce the impacts of several natural Earth processes on humans. (ESS3)

- Define a simple design problem including detailed criteria for success and constraints; generate and compare multiple detailed solutions to a problem; and plan and carry out fair tests to identify more than one way to improve a model or prototype. (ETS1)

Level 3

Students at **Level 3** demonstrate evidence of satisfactory understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences. In addition to demonstrating the skills and understandings at Level 2, students performing at Level 3 can be expected to be able to demonstrate knowledge and skills like in the following examples, as evidence of satisfactory understanding and use of the science standards:

- Develop and use a model to describe phenomena using an understanding of matter as tiny particles, measure and graph quantities to describe phenomena using an understanding of conservation of matter during physical or chemical changes, make observations and measurements to identify materials based on their properties, and conduct an investigation to determine whether a new substance with different properties is formed when two substances are mixed. (PS1)
- Plan and conduct an investigation to provide one piece of evidence about phenomena using an understanding of the effects of balanced and unbalanced forces on the motion of an object, predict the future motion of an object based on patterns in observations and measurements, ask questions to describe phenomena using an understanding of cause and effect of electric or magnetic interactions between objects not in contact with each other, define a simple design problem that can be solved using magnets, and support an argument with one piece of evidence about phenomena using an understanding that the gravitational force of Earth on objects is directed down. (PS2)
- Construct an explanation supported by one piece of evidence about phenomena using an understanding of the relationship between the speed and energy of an object; provide evidence that energy can be transferred from place to place; predict outcomes for the changes in energy that occur when objects collide; design, test, and refine a device that converts energy from one form to another; and use models to describe phenomena using an understanding that food energy was once energy from the Sun. (PS3)
- Develop models to describe phenomena using an understanding that waves can cause objects to move and that light allows objects to be seen; and compare multiple solutions that use patterns to transfer information. (PS4)
- Develop models to describe phenomena using an understanding of the diversity and commonalities of the life cycles of organisms, construct an argument supported by one piece of evidence about phenomena using an understanding that plants and animals have internal and external structures that support life functions, describe phenomena using an understanding that animals receive, process, and respond to information from their senses, and support an

argument with one piece of evidence about phenomena using an understanding that plants get the materials they need for growth chiefly from air and water. (LS1)

- Construct an argument supported by one piece of evidence about phenomena using an understanding that some animals form groups that help members survive; and develop a model to describe phenomena using an understanding of the movement of matter among plants, animals, decomposers, and the environment. (LS2)
- Analyze and interpret data to provide one piece of evidence about phenomena using an understanding that plants and animals have inherited traits and that variation of these traits exists in groups of similar organisms; and support an explanation with one piece of evidence about phenomena using an understanding that traits can be influenced by the environment. (LS3)
- Analyze and interpret fossil data to provide one piece of evidence of organisms and the environments in which they lived; construct an explanation supported by one piece of evidence of phenomena using an understanding that variation among individuals of the same species is a survival advantage and that in a particular habitat some organisms survive well, some survive less well, and some cannot survive at all; and make a claim supported by one piece of evidence about the merit of a solution to a problem caused by changes to the environment and the types of plants and animals that live there. (LS4)
- Describe phenomena using an understanding that patterns in rock formations and fossils in rock layers provide evidence to support an explanation for changes in a landscape over time, support an argument about phenomena using one piece of evidence and an understanding that differences in the apparent brightness of the Sun compared to other stars is due to their relative distances from Earth, and represent data in graphical displays to reveal patterns of daily changes in shadows, day and night, and the seasonal appearance of stars. (ESS1)
- Represent data to describe typical seasonal weather conditions, combine information to describe climates in different regions of the world, provide one piece of evidence for phenomena using an understanding of the effects of weathering or the rate of erosion, analyze and interpret data from maps to describe patterns of Earth's features, develop a model to describe phenomena using an understanding of how Earth's systems interact, and describe and graph the percentages of water to provide one piece of evidence about the distribution of water on Earth. (ESS2)
- Make a claim supported by one piece of evidence about the merit of a design solution that reduces the impacts of a weather-related hazard, combine information to describe how energy and fuels are derived from natural resources, how their uses affect the environment, and ways individual communities protect Earth's resources and the environment, and generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. (ESS3)
- Define a simple design problem including criteria for success and constraints; generate and compare multiple solutions to a problem; and plan and carry out fair tests to identify one way to improve a model or prototype. (ETS1)

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Level 2

Students at **Level 2** demonstrate evidence of partial understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences. Students performing at Level 2 can be expected to be able to demonstrate knowledge and skills like in the following examples, as evidence of partial understanding and use of the science standards:

- Use a model to describe phenomena using an understanding of matter as tiny particles, graph quantities to describe phenomena using an understanding of conservation of matter during physical or chemical changes, make observations to identify materials based on their properties, and use data to determine whether a new substance with different properties is formed when two substances are mixed. (PS1)
- Conduct an investigation to provide one piece of evidence about phenomena using an understanding of the effects of balanced or unbalanced forces on the motion of an object, predict the future motion of an object based on simple patterns in observations and measurements, ask questions using an understanding of cause and effect of electric or magnetic interactions between objects not in contact with each other, partially define a simple design problem that can be solved using magnets, and make a claim about phenomena using an understanding that the gravitational force of Earth on objects is directed down. (PS2)
- Describe phenomena using an understanding of the relationship between the speed and energy of an object, explain that energy can be transferred from place to place, describe the changes in energy that occur when objects collide, describe elements of a device that converts energy from one form to another, and describe phenomena using an understanding that food energy was once energy from the Sun. (PS3)
- Use models to describe phenomena using an understanding that waves can cause objects to move or that light allows objects to be seen; and describe a solution that uses patterns to transfer information. (PS4)
- Use models to describe phenomena using an understanding of the diversity and commonalities of the life cycles of organisms, make a claim about phenomena using an understanding that plants and animals have internal and external structures that support life functions, describe phenomena using an understanding that animals receive or process or respond to information from their senses, and make a claim about phenomena using an understanding that plants get the materials they need for growth chiefly from air and water. (LS1)
- Make a claim about phenomena using an understanding that some animals form groups that help members survive; and use a model to describe phenomena using an understanding of the movement of matter among plants, animals, decomposers, and the environment. (LS2)
- Use data to describe phenomena using an understanding that plants and animals have inherited traits OR that variation of these traits exists in groups of similar organisms; and make a claim

about phenomena using an understanding that traits can be influenced by the environment. (LS3)

- Use fossil data to describe organisms and the environments in which they lived; describe phenomena using an understanding that variation among individuals of the same species is a survival advantage or that in a particular habitat some organisms survive well, some survive less well, and some cannot survive at all; and describe a solution to a problem caused by changes to the environment and the types of plants and animals that live there. (LS4)
- Describe phenomena using an understanding that patterns in rock formations or fossils in rock layers provide evidence to support changes in a landscape over time, describe phenomena using an understanding that differences in the apparent brightness of the Sun compared to other stars is due to their relative distances from Earth, and use data in graphical displays to reveal patterns of daily changes in shadows or day and night or the seasonal appearance of stars. (ESS1)
- Use data to describe typical seasonal weather conditions, describe climates in different regions of the world, describe phenomena using an understanding of the effects of weathering or the rate of erosion, use maps to describe patterns of Earth's features, use a model to describe phenomena using an understanding of how Earth's systems interact, and provide a description of the distribution of water on Earth. (ESS2)
- Describe a design solution or component of a design solution that reduces the impacts of a weather-related hazard, use information to determine that energy and fuels are derived from natural resources or how their uses affect the environment or ways individual communities protect Earth's resources and the environment, and describe a solution or component of a solution to reduce the impacts of natural Earth processes on humans. (ESS3)
- Define a simple design problem including at least one criteria for success or one constraint; generate a solution to a problem or compare two solutions to a problem; and use results of a fair test to identify one way to improve a model or prototype. (ETS1)

Level 1

Students at **Level 1** demonstrate evidence of emerging understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences.

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Proficiency Level Descriptors

Grade 8

Policy PLDs

Policy PLDs define the knowledge and skill level expectations for all grades and content.

Level 4

Students demonstrate evidence of **thorough** understanding and use of college and career readiness knowledge, skills, and abilities.

Level 3

Students demonstrate evidence of **satisfactory** understanding and use of college and career readiness knowledge, skills, and abilities.

Level 2

Students demonstrate evidence of **partial** understanding and use of college and career readiness knowledge, skills, and abilities.

Level 1

Students demonstrate evidence of **emerging** understanding and use of college and career readiness knowledge, skills, and abilities.

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Range PLDs

Range PLDs describe the knowledge and skills that students throughout the range of each proficiency level are expected to be able to demonstrate. In line with the nature of the science standards, the statements combine science and engineering practices, disciplinary core ideas, and crosscutting concepts that students are expected to integrate and demonstrate.

Level 4

Students at **Level 4** demonstrate evidence of thorough understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences. In addition to demonstrating the skills and understanding at Level 3, students performing at Level 4 can be expected to be able to demonstrate knowledge and skills like in the following examples, as evidence of thorough understanding and use of the science standards:

- Develop, use, and analyze models to describe or explain phenomena using an understanding of the structure of matter; to predict, describe, and explain phenomena using an understanding of changes in particle motion and state; and to provide evidence for and describe phenomena using an understanding of conservation of mass during multiple physical and chemical changes. (PS1)
- Plan, carry out, and refine investigations to provide evidence to explain phenomena using an understanding of the effects of forces, interactions, and mass on the motion of objects, as well as analyze various data to evaluate claims about phenomena using an understanding of gravitational interactions in systems, and to design and/or compare multiple solutions to a problem using an understanding of systems of colliding objects. (PS2)
- Plan, carry out, and refine investigations, use and analyze data, and develop, use, and analyze models to explain phenomena using an understanding of various relationships involving kinetic and potential energy in systems, as well as apply such understanding to design, test, and evaluate devices to solve problems related to energy transfer and to support and/or evaluate claims about phenomena related to energy transfer. (PS3)
- Develop, use, and apply mathematical representations, patterns, and models to explain phenomena using an understanding of wave properties and relationships and wave interactions with various materials, and synthesize multiple sources of information using an understanding of signal types to evaluate claims about phenomena related to reliability of digital and analog signals. (PS4)
- Use multiple pieces of evidence from investigations of phenomena to explain that living things are made of cells; develop and use models of phenomena to describe the function of a cell and its parts and to describe how food is rearranged in organisms through chemical reactions to support growth and/or release energy; support arguments about phenomena using multiple pieces of evidence and an understanding that the body is a system of interacting subsystems composed of cells; support an explanation for how several animal behaviors and several specialized plant structures affect the probability of reproductive success; use multiple pieces of evidence and an understanding of environmental and genetic factors to explain phenomena

about how those factors influence the growth of organisms; construct an explanation using multiple pieces of evidence to explain the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms; synthesize multiple sources of information about phenomena and an understanding of behaviors of organisms to determine that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or for storage as memories. (LS1)

- Analyze and interpret data about phenomena to provide evidence to explain multiple ways that resource availability affects populations, construct an argument supported by multiple pieces of evidence that populations are affected by changing physical and biological components of an ecosystem, develop and revise models to explain phenomena using an understanding of the cycling of matter and energy in an ecosystem, describe phenomena using an understanding of interactions among organisms and predict multiple patterns of interactions among organisms across multiple ecosystems, and evaluate multiple competing design solutions for phenomena that involve maintaining biodiversity in ecosystems. (LS2)
- Develop and use multiple models to explain phenomena using an understanding of how genetic mutations affect proteins resulting in harmful, beneficial, or neutral effects on an organism, and to explain phenomena using an understanding of how asexual reproduction results in offspring with identical genetic information and to explain how sexual reproduction results in offspring with genetic variation. (LS3)
- Analyze and interpret multiple pieces of data about phenomena using an understanding of the fossil record and modern organisms to show patterns in the change of life forms over time, apply multiple scientific ideas about phenomena to construct an explanation for the anatomical similarities and differences among modern and fossil organisms to infer evolutionary relationships, analyze pictorial data to compare similarities in embryological development across multiple familiar and unfamiliar species to identify evolutionary relationships, use multiple pieces of evidence and mathematical representations to explain phenomena using an understanding of how variation in genetic traits provides advantages to some individuals within a population and to support explanations of increases and decreases in specific traits over time, and explain phenomena by synthesizing multiple pieces of information about ways technologies have changed the way humans influence the inheritance of desired traits in organisms. (LS4)
- Develop, use, and revise a model of the Earth-Sun-Moon system to describe phenomena using an understanding of the cyclic pattern of the seasons and to describe phenomena using an understanding of the role of gravity in the motions within the solar system and galaxies, analyze and interpret data on multiple phenomena related to the scale properties of objects in the solar system, and use multiple pieces of evidence and an understanding of rock strata to explain phenomena about how the geologic time scale is used to organize Earth's history. (ESS1)
- Develop models to describe phenomena using an understanding of the flow of energy that drives the cycling of Earth's materials, use multiple pieces of evidence to explain phenomena using an understanding of how geoscience processes have changed Earth's surface at varying time and spatial scales, analyze and interpret multiple pieces of data to explain phenomena

using an understanding of the evidence that supports past plate motions on Earth, develop models to describe phenomena using an understanding of the water cycle including energy and gravity, explain weather phenomena synthesizing and using evidence and an understanding of the interactions of air masses, and develop and use models to describe phenomena using an understanding of how unequal heating and Earth's rotation result in climate, atmospheric, and ocean circulation patterns. (ESS2)

- Use evidence to explain multiple phenomena using an understanding of how geoscience processes have resulted in uneven distribution of Earth's natural resources, analyze and interpret multiple pieces of data on natural hazard phenomena to forecast future catastrophic events and to inform the development of technologies to mitigate their effects, apply scientific principles to design a successful solution for monitoring and minimizing the human impacts on the environment, use multiple pieces of evidence to support an argument about phenomena using an understanding of how increases in human population impact Earth's systems, and ask multiple questions about phenomena to clarify evidence of multiple factors that have caused the rise in global temperatures. (ESS3)
- Define the criteria and constraints of a design problem with sufficient precision to ensure an optimal solution and using an understanding of scientific principles and potential impacts on people and the environment and an understanding of how those impacts may limit possible solutions, use a systematic process to evaluate how well multiple competing design solutions meet required criteria and constraints, analyze data from tests of multiple different design solutions to identify the best characteristics of each solution that can be combined into a new solution that will better meet criteria for success, and develop a realistic model of a proposed object, tool, or process that generates data while it is repeatedly tested and modified until an optimal design is achieved. (ETS1)

Level 3

Students at **Level 3** demonstrate evidence of satisfactory understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences. In addition to demonstrating the skills and understanding at Level 2, students performing at Level 3 can be expected to be able to demonstrate knowledge and skills like in the following examples, as evidence of satisfactory understanding and use of the science standards:

- Develop and use models to describe phenomena using an understanding of the structure of matter; to predict and describe phenomena using an understanding of changes in particle motion and state; and to describe phenomena using an understanding of conservation of mass during one or two physical and chemical changes. (PS1)
- Plan and carry out investigations to produce data and/or provide evidence about phenomena using an understanding of the effects of forces, interactions, and mass on the motion of objects, as well as use direct data to support claims about phenomena using an understanding of

gravitational interactions in systems and to design a solution to a problem using an understanding of systems of colliding objects. (PS2)

- Plan investigations, use data, and develop or use models to describe phenomena using an understanding of relationships involving kinetic and potential energy in systems, as well as apply such understanding to design and test devices to solve problems related to energy transfer and to support claims about phenomena related to energy transfer. (PS3)
- Use mathematical representations and patterns, and develop and use models, to describe phenomena using an understanding of wave properties and relationships and wave interactions with various materials, and use multiple sources of information and an understanding of signal types to support claims about phenomena related to reliability of digital and analog signals. (PS4)
- Use one or two pieces of evidence from investigations of phenomena to explain that living things are made of cells, develop and use models of phenomena to describe the function of a cell and its parts and to describe how food is rearranged in organisms through chemical reactions to support growth and/or release energy, support arguments about phenomena using one or two pieces of evidence and an understanding that the body is a system of interacting subsystems composed of cells, support an explanation for how some animal behaviors and some specialized plant structures affect the probability of reproductive success, use one or two pieces of evidence and an understanding of environmental and genetic factors to explain phenomena about how those factors influence the growth of organisms, construct an explanation based on one or two pieces of evidence to explain the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms, use information about phenomena and an understanding of behaviors of organisms to determine that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or for storage as memories. (LS1)
- Analyze and interpret data about phenomena to provide evidence to explain one or two ways that resource availability affects populations, construct an argument supported by one or two pieces of evidence that populations are affected by changing physical or biological components of an ecosystem, develop models to describe phenomena using an understanding of the cycling of matter and energy in an ecosystem, describe phenomena using an understanding of interactions among organisms and predict one or two patterns of interactions among organisms across multiple ecosystems, and evaluate two competing design solutions for phenomena that involve maintaining biodiversity in ecosystems. (LS2)
- Develop and use one or two models to explain phenomena using an understanding of how genetic mutations affect proteins resulting in harmful, beneficial, or neutral effects on an organism and to explain phenomena using an understanding of how asexual reproduction results in offspring with identical genetic information and how sexual reproduction results in offspring with genetic variation. (LS3)
- Analyze and interpret one or two pieces of data about phenomena using an understanding of the fossil record and modern organisms to show patterns in the change of life forms over time,

apply one or two scientific ideas about phenomena to construct an explanation for the anatomical similarities and differences among modern and fossil organisms to infer evolutionary relationships, analyze pictorial data to compare similarities in embryological development across multiple familiar species to identify evolutionary relationships, use one or two pieces of evidence or mathematical representations to explain phenomena using an understanding of how variation in genetic traits provides advantages to some individuals within a population and to support explanations of increases and decreases in specific traits over time, and explain phenomena by synthesizing one or two pieces of information about technologies that have changed the way humans influence the inheritance of desired traits in organisms. (LS4)

- Develop and use a model of the Earth-Sun-Moon system to describe phenomena using an understanding of the cyclic pattern of the seasons and to describe phenomena using an understanding of the role of gravity in the motions within the solar system and galaxies, analyze and interpret data on one or two phenomena related to the scale properties of objects in the solar system, and use one or two pieces of evidence and an understanding of rock strata to explain phenomena about how the geologic time scale is used to organize Earth's history. (ESS1)
- Develop a model to describe phenomena using an understanding of the flow of energy that drives cycling of Earth's materials, use one or two pieces of evidence to explain phenomena using an understanding of how geoscience processes have changed Earth's surface at varying time and spatial scales, analyze and interpret one or two pieces of data to explain phenomena using an understanding of the evidence that supports past plate motions on Earth, develop a model to describe phenomena using an understanding of the water cycle including energy and gravity, explain weather phenomena using evidence and an understanding of the interactions of air masses, and develop and use a model to describe phenomena using an understanding of how unequal heating and Earth's rotation result in climate, atmospheric, or ocean circulation patterns. (ESS2)
- Use evidence to explain one or two phenomena using an understanding of how geoscience processes have resulted in uneven distribution of Earth's natural resources, analyze and interpret one or two pieces of data on natural hazard phenomena to forecast future catastrophic events and to inform the development of technologies to mitigate their effects, apply scientific principles to design a solution for monitoring and minimizing human impacts on the environment, use one or two pieces of evidence to support an argument about phenomena using an understanding of how increases in human population impact Earth's systems, and ask one or two questions about phenomena to clarify evidence of one or two factors that have caused the rise in global temperatures. (ESS3)
- Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution and using an understanding of scientific principles and potential impacts on people and the environment and an understanding of how those impacts may limit possible solutions, use a systematic process to evaluate how well two competing design solutions meet required criteria and constraints, analyze data from tests of two different design solutions to identify the best characteristics of each solution that can be combined into a new solution that

will better meet criteria for success, and develop a model of a proposed object, tool, or process that generates data while it is repeatedly tested and modified until an optimal design is achieved. (ETS1)

Level 2

Students at **Level 2** demonstrate evidence of partial understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences. Students performing at Level 2 can be expected to be able to demonstrate knowledge and skills like in the following examples, as evidence of partial understanding and use of the science standards:

- Use models to identify the structure of matter as it relates to phenomena; to describe basic phenomena using an understanding of changes in particle motion and state; and to identify that mass is conserved during physical or chemical changes that take place in various phenomena. (PS1)
- Identify or describe parts of investigations about phenomena using an understanding of the effects of forces, interactions, and mass on the motion of objects, describe aspects of phenomena using one or two pieces of data and an understanding of one gravitational interaction in a system, and identify a design or elements of a solution to a problem related to colliding objects. (PS2)
- Describe parts of investigations, use data, and use models to describe aspects of phenomena using an understanding of some relationships involving kinetic energy in systems; design and test a device for problems related to energy transfer; and identify principles that support claims about energy transfer in phenomena. (PS3)
- Use mathematical representations, patterns, and models to identify wave properties and wave interactions with various materials as they relate to phenomena and use one or two sources of information to identify that digital signals are more reliable than analog signals as demonstrated in various phenomena. (PS4)
- Use evidence from an investigation of a phenomenon to explain that living things are made of cells, use models of phenomena to describe the function of a cell and some of its parts and to describe that food is rearranged in organisms into new substances to support growth or to release energy, make claims about phenomena using evidence and a partial understanding that the body is a system of interacting subsystems composed of cells, describe some animal behaviors or specialized plant structures that may affect reproductive success, use evidence and a partial understanding of environmental or genetic factors to describe phenomena about how those factors influence the growth of organisms, construct an explanation based on one piece of evidence to describe the role of photosynthesis in the cycling of matter or flow of energy into and out of organisms, and use information about phenomena to describe that organisms use their senses to respond to stimuli immediately or to store information as memories. (LS1)

- Use data about phenomena to describe one way resource availability affects populations, make a claim supported by evidence that populations are affected by changing components of an ecosystem, use models to describe phenomena about the cycling of matter or energy in an ecosystem, use a partial understanding of interactions among organisms to describe one interaction between organisms, and describe a design solution or components of a solution for phenomena that involve maintaining biodiversity in ecosystems. (LS2)
- Use models to partially explain phenomena using an understanding of one way that genetic mutations affect organisms and to describe phenomena using an understanding of asexual reproduction resulting in offspring with identical genetic information, or about sexual reproduction resulting in offspring with genetic variation. (LS3)
- Use data about phenomena using a partial understanding of the fossil record and modern organisms to show patterns in the change of life forms over time, apply a scientific idea about phenomena to describe an anatomical similarity or difference between modern and fossil organisms, use pictorial data to describe similarities in embryological development across multiple species, use evidence or one mathematical representation to describe phenomena using a partial understanding of variation in genetic traits among individuals within a population or to describe increases and decreases in specific traits over time, and describe phenomena using a partial understanding about technologies that have changed the way humans influence the inheritance of desired traits in organisms. (LS4)
- Use a model of the Earth-Sun-Moon system to describe phenomena using a partial understanding of the cyclic pattern of the seasons and to describe phenomena using a partial understanding of the role of gravity in the motions within the solar system or galaxies, use data on phenomena related to the scale properties of objects in the solar system, and use evidence and a partial understanding of rock strata to describe some aspects about how the geologic time scale is related to Earth's history. (ESS1)
- Use a model to describe phenomena using a partial understanding of the flow of energy that drives the cycling of Earth's materials, use evidence to explain phenomena using a partial understanding of how geoscience processes have changed Earth's surface, use data to explain phenomena using a partial understanding of the evidence that supports past plate motions on Earth, use a model to describe phenomena using an understanding of the water cycle, describe weather phenomena using evidence and a partial understanding of the interactions of air masses, and use a model to describe phenomena using an understanding of how unequal heating and Earth's rotation result in some climate, atmospheric, or ocean circulation patterns. (ESS2)
- Use evidence to explain a phenomenon using a partial understanding of how geoscience processes have resulted in uneven distribution of some of Earth's natural resources, use data on natural hazard phenomena to forecast future catastrophic events or to inform the development of one technology that could be used to mitigate their effects, identify human impacts on the environment or design parts of a solution for monitoring or minimizing the human impacts, use evidence to make a claim about phenomena using a partial understanding of how increases in

human population impact Earth's systems, and ask one question about a phenomenon to clarify evidence of one factor that has caused the rise in global temperatures. (ESS3)

- Define one criterion or constraint of a design problem using an understanding of scientific principles and/or potential impacts on people and the environment and identify one way those impacts may limit possible solutions, use a systematic process to evaluate how well a design solution meets required criteria or constraints, analyze data from tests of a design solution to identify a characteristic of the solution that is necessary to meet the criteria for success, and develop a partial model of a proposed object, tool, or process that can be tested and modified. (ETS1)

Level 1

Students at **Level 1** demonstrate evidence of emerging understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences.

Proficiency Level Descriptors

Grade 11

Policy PLDs

Policy PLDs define the knowledge and skill level expectations for all grades and content areas.

Level 4

Students demonstrate evidence of **thorough** understanding and use of college and career readiness knowledge, skills, and abilities.

Level 3

Students demonstrate evidence of **satisfactory** understanding and use of college and career readiness knowledge, skills, and abilities.

Level 2

Students demonstrate evidence of **partial** understanding and use of college and career readiness knowledge, skills, and abilities.

Level 1

Students demonstrate evidence of **emerging** understanding and use of college and career readiness knowledge, skills, and abilities.

VERMONT
AGENCY OF EDUCATION

Range PLDs

Range PLDs describe the knowledge and skills that students throughout the range of each proficiency level are expected to be able to demonstrate. In line with the nature of the science standards, the statements combine science and engineering practices, disciplinary core ideas, and crosscutting concepts that students are expected to integrate and demonstrate.

Level 4

Students at **Level 4** demonstrate evidence of thorough understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences. In addition to demonstrating the skills and understanding at Level 3, students performing at Level 4 can be expected to be able to demonstrate knowledge and skills like in the following examples, as evidence of thorough understanding and use of the science standards:

- Use an understanding of the periodic table to predict multiple relative properties of elements, plan and conduct an investigation of phenomena related to multiple bulk scale properties of substances and explain how these relate to the strength of electrical forces between particles, explain phenomena about the release or absorption of energy by a chemical system by developing models to show changes in total bond energy, use multiple pieces of evidence to explain phenomena using an understanding of how changes in temperature and concentration affect reaction rate, explain phenomena about chemical systems at equilibrium using an understanding of how multiple conditions on the system could be changed to produce more or fewer products or more or fewer reactants, use multiple mathematical representations to support claims that mass is conserved during a chemical reaction, and develop multiple models to describe phenomena using an understanding of the changes in the nucleus of an atom and the energy released during fission, fusion, and radioactive decay. (PS1)
- Analyze and use multiple pieces of data from phenomena to show that f = ma; use multiple mathematical representations of phenomena and an understanding of momentum to support the claim that the total momentum of a system is conserved when there is no net force on the system; apply multiple scientific and engineering ideas to design, evaluate, and refine multiple devices that minimize force on an object during a collision; use mathematical representations of Newton's law of gravitation and Coulomb's law to describe and make predictions about familiar and unfamiliar phenomena using an understanding of gravitational and electrostatic forces between objects; plan and conduct an investigation of phenomena to produce multiple pieces of evidence that prove an electric current produces a magnetic field and that a changing magnetic field produces electric current; and communicate multiple pieces of information about phenomena using an understanding of how the molecular structure of a material relates to its macroscopic properties and makes the material well suited for particular uses. (PS2)
- Create multiple computational models of phenomena to calculate changes in energy of a system when energy flows into and out of the system is known; develop and use multiple models to

explain phenomena using an understanding of how energy at the macroscopic scale can be accounted for at the microscopic scale in energy associated with particle motion and relative position; design, build, and refine devices that convert one form of energy into another; plan and conduct an investigation of phenomena to provide multiple pieces of evidence using an understanding that when two components of different temperatures are combined within a closed system, both components eventually have the same temperature; and develop and use a model to explain phenomena related to the forces and the changes in energy between two objects interacting through electric fields and magnetic fields. (PS3)

- Explain phenomena using an understanding of multiple mathematical representations regarding relationships among frequency, wavelength, and speed of waves in various media; evaluate multiple questions about phenomena using an understanding of the advantages of using digital transmission and storage of information; use multiple phenomena to evaluate claims that electromagnetic radiation can be described using a wave or particle model; in the context of phenomena, evaluate multiple claims about the effects that different frequencies of electromagnetic radiation have on matter; and communicate technical information about phenomena using an understanding of how multiple specific technological devices use the principles of wave behavior and wave interactions to transmit and capture information and energy. (PS4)
- Use multiple pieces of evidence to explain phenomena using an understanding of how the structure of DNA determines the structure of proteins and how proteins carry out the functions of life through specialized cells; develop and use a complex model to describe phenomena using an understanding of the organization of interacting systems within multicellular organisms; plan and conduct an investigation to provide multiple pieces of evidence about phenomena that show that feedback mechanisms maintain homeostasis; use a complex model to describe phenomena using an understanding of how cell division and differentiation help produce and maintain complex organisms; use a complex model to describe phenomena using an understanding of how photosynthesis transforms light energy into stored chemical energy; use multiple pieces of evidence to construct and revise an explanation about phenomena using an understanding of how carbon, hydrogen, and oxygen from sugar molecules combine with other elements to form amino acids and other large carbon-based molecules; and use a complex model to describe phenomena using an understanding that cellular respiration is a chemical process that breaks the bonds in food and oxygen molecules and forms bonds in new compounds, which results in a net transfer of energy. (LS1)
- Use mathematical and computational representations to support explanations of phenomena using an understanding of factors that affect carrying capacity of ecosystems at different scales; use multiple pieces of evidence and mathematical representations to support and revise explanations of phenomena using an understanding of factors affecting biodiversity and populations in ecosystems of different scales and to support claims for the cycling of matter and flow of energy among organisms in an ecosystem; use evidence to construct and revise an explanation of phenomena using an understanding of the cycling of matter and flow of energy in aerobic and anaerobic conditions; develop models to describe phenomena using an understanding of the role of photosynthesis and cellular respiration in the cycling of carbon among Earth's spheres; evaluate multiple claims, pieces of evidence, and reasoning about phenomena involving complex interactions in ecosystems using an understanding that these

interactions maintain relatively consistent numbers and types of organisms under stable conditions, but changing conditions may result in a new ecosystem; design, evaluate, and refine solutions for reducing impacts of human activities on the environment or biodiversity; and evaluate multiple pieces of evidence about phenomena using an understanding of the role of group behavior on individual and species' chances to survive and reproduce. (LS2)

- Ask multiple questions about phenomena to clarify relationships surrounding the role of DNA in chromosomes in coding the instructions for traits passed from parents to offspring; use multiple pieces of evidence to make and defend a claim about phenomena using an understanding that inheritable genetic variations may result from new genetic combinations through meiosis, viable errors during replication, and/or mutations caused by environmental factors; and apply multiple concepts of statistics and probability to explain phenomena using an understanding of the variation and distribution of expressed traits in a population. (LS3)
- Communicate multiple pieces of scientific information about phenomena using an understanding that common ancestry and biological evolution are supported by multiple lines of empirical evidence; use multiple pieces of evidence to construct an explanation about phenomena using an understanding that the process of evolution primarily results from four factors: the potential for a species to increase in number, the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, competition for limited resources, and the proliferation of those organisms that are better able to survive and reproduce in the environment; apply multiple concepts of statistics and probability to support explanations of phenomena using an understanding that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking the trait; use multiple pieces of evidence to construct an explanation of phenomena using an understanding of how natural selection leads to adaptation of populations; evaluate multiple pieces of evidence supporting claims about phenomena using an understanding that changes in environmental conditions may result in: increases in numbers of individuals of some species, the emergence of new species over time, and the extinction of other species; and create and revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (LS4)
- Use multiple pieces of evidence to develop a model to describe phenomena using an understanding of the life span of the Sun and the role of nuclear fusion in the Sun's core to release energy that reaches Earth in the form of radiation; use multiple pieces of evidence and an understanding of the phenomena of light spectra, motion of distant galaxies, and composition of matter in the universe to construct an explanation of the big bang theory; communicate multiple scientific ideas about phenomena using an understanding of the way stars produce different elements over their life cycles; use mathematical and computational representations of phenomena to predict the motion of orbiting objects in the solar system; evaluate multiple pieces of evidence of phenomena using an understanding of past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks; and apply scientific reasoning and an understanding of multiple pieces of

evidence from ancient Earth materials, meteorites, and other planetary surfaces to describe phenomena about Earth's formation and early history. (ESS1)

- Develop models to describe phenomena using an understanding of how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean floor features; analyze multiple types of geoscience data about phenomena to make a claim that one change to Earth's surface can create feedback that causes changes to other Earth systems; use multiple pieces of evidence to develop a model of Earth's interior to describe phenomena using an understanding of the cycling of matter by thermal convection; use models to describe phenomena using an understanding of how variations in the flow of energy into and out of Earth's systems result in changes in climate; plan and conduct investigations of phenomena related to the properties of water using an understanding of water's effects on Earth materials and surface processes; develop quantitative models to describe phenomena using an understanding of the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere; and use multiple pieces of evidence to construct an argument about phenomena using an understanding of the simultaneous coevolution of Earth's systems and life on Earth. (ESS2)
- Use multiple pieces of evidence to construct an explanation about phenomena using an understanding of how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity; using an understanding of cost-benefit ratios, evaluate multiple competing design solutions for developing, managing, and utilizing energy and mineral resources; create computational simulations of phenomena to show the relationships among management of natural resources, the sustainability of human populations, and biodiversity; using an understanding of human impacts on natural systems, evaluate and refine a technological solution that reduces these impacts; analyze multiple pieces of geoscience data and multiple global climate models of phenomena to make a forecast of the current rate of climate change and associated future impacts to Earth systems; and use computational representations to describe phenomena using an understanding of the relationships among Earth systems and how those relationships are modified due to human activity. (ESS3)
- Analyze a major global challenge to specify multiple qualitative and quantitative criteria and constraints for solutions that account for multiple societal needs and wants; design an engineering solution to multiple complex real-world problems by breaking them down into smaller, more manageable problems; evaluate and refine a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as social, cultural, and environmental impacts; and use a computer simulation to model the impact of multiple proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. (ETS1)

Level 3

Students at Level 3 demonstrate evidence of satisfactory understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences. In addition to demonstrating the skills and understanding at Level 2, students performing at Level 3 can be expected to be able to demonstrate knowledge and skills like in the following examples, as evidence of satisfactory understanding and use of the science standards:

- Use an understanding of the periodic table to predict one or two relative properties of elements, plan and conduct an investigation of phenomena related to one or two bulk scale properties of substances and explain how these relate to the strength of electrical forces between particles, explain phenomena about the release or absorption of energy by a chemical system by developing a model to show changes in total bond energy, use one or two pieces of evidence to explain phenomena using an understanding of how changes in temperature or concentration affect reaction rate, explain phenomena about chemical systems at equilibrium using an understanding of how one or two of the conditions on the system could be changed to produce more products, use one or two mathematical representations to support claims that mass is conserved during a chemical reaction, and develop one or two models to describe phenomena using an understanding of the changes in the nucleus of an atom and the energy released during fission, fusion, and radioactive decay. (PS1)
- Analyze and use one or two pieces of data from phenomena to show that f = ma; use one or two mathematical representations of phenomena and an understanding of momentum to support the claim that the total momentum of a system is conserved when there is no net force on the system; apply one or two scientific and engineering ideas to design, evaluate, and refine a device that minimizes force on an object during a collision; use mathematical representations of Newton's law of gravitation and Coulomb's law to describe and make predictions about familiar phenomena using an understanding of gravitational and electrostatic forces between objects; plan and conduct an investigation of phenomena to produce one or two pieces of evidence that prove an electric current produces a magnetic field and that a changing magnetic field produces electric current; and communicate one or two pieces of information about phenomena using an understanding of how the molecular structure of a material relates to its macroscopic properties and makes the material well suited for particular uses. (PS2)
- Create a computational model of phenomena to calculate changes in energy of a system when energy flows into and out of the system is known; develop and use one or two models to explain phenomena using an understanding of how energy at the macroscopic scale can be accounted for at the microscopic scale in energy associated with particle motion and relative position; design, build, and refine a device that converts one form of energy into another; plan and conduct an investigation of phenomena to provide one or two pieces of evidence using an understanding that when two components of different temperatures are combined within a closed system, both components eventually have the same temperature; and develop and use a

model to explain phenomena related to the forces and the changes in energy between two objects interacting through electric or magnetic fields. (PS3)

- Explain phenomena using an understanding of one or two mathematical representations regarding relationships among frequency, wavelength, and speed of waves in various media; evaluate one or two questions about phenomena using an understanding of the advantages of using digital transmission and storage of information; use one or two phenomena to evaluate claims that electromagnetic radiation can be described using a wave or particle model; in the context of phenomena, evaluate one or two claims about the effects that different frequencies of electromagnetic radiation have on matter; and communicate technical information about phenomena using an understanding of how one or two specific technological devices use the principles of wave behavior and wave interactions to transmit and capture information and energy. (PS4)
- Use evidence to explain phenomena using an understanding of how the structure of DNA determines the structure of proteins and how proteins carry out the functions of life through specialized cells; develop and use a model to describe phenomena using an understanding of the organization of interacting systems within multicellular organisms; plan and conduct an investigation to provide evidence about phenomena that show that feedback mechanisms maintain homeostasis; use a model to describe phenomena using an understanding of how cell division and differentiation help produce and maintain complex organisms; use a model to describe phenomena using an understanding of how photosynthesis transforms light energy into stored chemical energy; use evidence to construct and revise an explanation about phenomena using an understanding of how carbon, hydrogen, and oxygen from sugar molecules combine with other elements to form amino acids and/or other large carbon-based molecules; and use a model to describe phenomena using an understanding that cellular respiration is a chemical process that breaks the bonds in food and oxygen molecules and forms bonds in new compounds, which results in a net transfer of energy. (LS1)
- Use mathematical or computational representations to support explanations of phenomena using an understanding of factors that affect carrying capacity of ecosystems at different scales; use one or two pieces of evidence and one or two mathematical representations to support and revise explanations of phenomena using an understanding of factors affecting biodiversity and populations in ecosystems of different scales and to support claims for the cycling of matter and flow of energy among organisms in an ecosystem; use evidence to construct or revise an explanation of phenomena using an understanding of the cycling of matter and flow of energy in aerobic and anaerobic conditions; develop a model to describe phenomena using an understanding of the role of photosynthesis and cellular respiration in the cycling of carbon among Earth's spheres; evaluate one or two claims, pieces of evidence, and reasoning about phenomena involving complex interactions in ecosystems using an understanding that these interactions maintain relatively consistent numbers and types of organisms under stable conditions, but changing conditions may result in a new ecosystem; design, evaluate, and refine a solution for reducing impacts of human activities on the environment or biodiversity; and

evaluate one or two pieces of evidence about phenomena using an understanding of the role of group behavior on individual and species' chances to survive and reproduce. (LS2)

- Ask one or two questions about phenomena to clarify relationships about the role of DNA in chromosomes in coding the instructions for traits passed from parents to offspring; use one or two pieces of evidence to make and defend a claim about phenomena using an understanding that inheritable genetic variations may result from new genetic combinations through meiosis, viable errors during replication, and/or mutations caused by environmental factors; and apply one or two concepts of statistics and probability to explain phenomena using an understanding of the variation and distribution of expressed traits in a population. (LS3)
- Communicate one or two pieces of scientific information about phenomena using an understanding that common ancestry and biological evolution are supported by multiple lines of empirical evidence; use one or two pieces of evidence to construct an explanation about phenomena using an understanding that the process of evolution primarily results from four factors: the potential for a species to increase in number, the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, competition for limited resources, and the proliferation of those organisms that are better able to survive and reproduce in the environment; apply one or two concepts of statistics and probability to support explanations of phenomena using an understanding that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking the trait; use one or two pieces of evidence to construct an explanation of phenomena using an understanding of how natural selection leads to adaptation of populations; evaluate one or two pieces of evidence supporting claims about phenomena using an understanding that changes in environmental conditions may result in: increases in numbers of individuals of some species, the emergence of new species over time, and the extinction of other species; and create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (LS4)
- Use one or two pieces of evidence to develop a model to describe phenomena using an understanding of the life span of the Sun and the role of nuclear fusion in the Sun's core to release energy that reaches Earth in the form of radiation; use one or two pieces of evidence and an understanding of the phenomena of light spectra, motion of distant galaxies, and composition of matter in the universe to construct an explanation of the big bang theory; communicate one or two scientific ideas about phenomena using an understanding of the way stars produce different elements over their life cycles; use mathematical or computational representations of phenomena to predict the motion of orbiting objects in the solar system; evaluate one or two pieces of evidence of phenomena using an understanding of past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks; and apply scientific reasoning and an understanding of one or two pieces of evidence from ancient Earth materials, meteorites, and other planetary surfaces to describe phenomena about Earth's formation and early history. (ESS1)
- Develop a model to describe phenomena using an understanding of how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and

ocean floor features; analyze one type of geoscience data about phenomena to make a claim that one change to Earth's surface can create feedback that causes changes to other Earth systems; use one or two pieces of evidence to develop a model of Earth's interior to describe phenomena using an understanding of the cycling of matter by thermal convection; use a model to describe phenomena using an understanding of how variations in the flow of energy into and out of Earth's systems result in changes in climate; plan and conduct an investigation of phenomena related to the properties of water using an understanding of water's effects on Earth materials and surface processes; develop a quantitative model to describe phenomena using an understanding of the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere; and use one or two pieces of evidence to construct an argument about phenomena using an understanding of the simultaneous coevolution of Earth's systems and life on Earth. (ESS2)

- Use one or two pieces of evidence to construct an explanation about phenomena using an understanding of how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity; using an understanding of cost-benefit ratios, evaluate two competing design solutions for developing, managing, and utilizing energy and mineral resources; create a computational simulation of phenomena to show the relationships among management of natural resources, the sustainability of human populations, and biodiversity; using an understanding of human impacts on natural systems, evaluate or refine a technological solution that reduces these impacts; analyze one or two pieces of geoscience data and one or two global climate models of phenomena to make a forecast of the current rate of climate change and associated future impacts to Earth systems; and use a computational representation to describe phenomena using an understanding of the relationships among Earth systems and how those relationships are modified due to human activity. (ESS3)
- Analyze a major global challenge to specify one or two qualitative and quantitative criteria and constraints for solutions that account for one or two societal needs and wants; design an engineering solution to a complex real-world problem by breaking it down into smaller, more manageable problems; evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as social, cultural, and environmental impacts; and use a computer simulation to model the impact of two proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. (ETS1)

Level 2

Students at **Level 2** demonstrate evidence of partial understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences.

Students performing at Level 2 can be expected to be able to demonstrate knowledge and skills like in the following examples, as evidence of partial understanding and use of the science standards:

- Use a partial understanding of the periodic table to predict one relative property of elements, conduct an investigation of phenomena related to bulk scale properties of substances or construct a partial explanation of how these relate to the strength of electrical forces between particles, describe phenomena about the release or absorption of energy by a chemical system, explain phenomena using a partial understanding of how changes in temperature or concentration affect reaction rate, explain phenomena about chemical systems at equilibrium using a partial understanding of how one condition on the system could be changed to produce more products, use a mathematical representation to support a claim that mass is conserved during a chemical reaction, and use models to describe phenomena using a partial understanding of the changes in the nucleus of an atom or the energy released during fission, fusion, or radioactive decay. (PS1)
- Use data from phenomena to show that f = ma, use a mathematical representation of a phenomenon and a partial understanding of momentum to support the claim that the total momentum of a system is conserved, apply a scientific or an engineering idea to design a device that minimizes force on an object during a collision, use mathematical representations of Newton's law of gravitation or Coulomb's law to describe phenomena using a partial understanding of gravitational and electrostatic forces between objects, conduct an investigation of phenomena to produce evidence that an electric current produces a magnetic field or that a changing magnetic field produces electric current, and communicate information about phenomena using a partial understanding of how the molecular structure of a material relates to its macroscopic properties or makes the material well suited for particular uses. (PS2)
- Use a computational model of phenomena to calculate changes in energy of a system when energy flows into and out of the system is known; use models to explain phenomena using a partial understanding of how energy at the macroscopic scale can be accounted for at the microscopic scale in energy associated with particle motion or relative position; design a device that converts one form of energy into another; conduct an investigation of phenomena that provides evidence using a partial understanding that when two components of different temperatures are combined within a closed system, both components eventually have the same temperature; and use a model to explain phenomena related to the forces or the changes in energy between two objects interacting through electric or magnetic fields. (PS3)
- Explain phenomena using an understanding of a mathematical representation regarding one relationship among frequency, wavelength, and speed of waves in various media; ask questions about phenomena using a partial understanding of the advantages of using digital transmission and storage of information; use one phenomenon to support a claim that electromagnetic radiation may be described using a wave or particle model; make a claim about phenomena related to the effects that different frequencies of electromagnetic radiation have on matter; and communicate information about phenomena using a partial understanding of how specific

technological devices use the principles of wave behavior or wave interactions to transmit or capture information and energy. (PS4)

- Use evidence to explain phenomena using a partial understanding of how the structure of DNA determines the structure of proteins; use a model to describe phenomena using a partial understanding of the organization of interacting systems within multicellular organisms; conduct an investigation to provide evidence about phenomena that show that some feedback mechanisms maintain homeostasis; use a model to describe phenomena using a partial understanding of how cell division or differentiation helps produce or maintain a complex organism; use a model to describe phenomena using a partial understanding of how photosynthesis transforms light energy into stored chemical energy; describe that carbon, hydrogen, and oxygen from sugar molecules combine with other elements to form amino acids or other large carbon-based molecules; and use a model to describe phenomena using a partial understanding that cellular respiration is a chemical process that breaks the bonds in food or oxygen molecules, forms bonds in new compounds, or results in a net transfer of energy. (LS1)
- Use mathematical or computational representations to support explanations of phenomena using a partial understanding of factors that affect carrying capacity of ecosystems; use evidence or mathematical representations to describe factors affecting biodiversity or populations in ecosystems and to support a claim for the cycling of matter or flow of energy among organisms in an ecosystem; use evidence to construct an explanation of phenomena using a partial understanding of the cycling of matter and flow of energy in aerobic or anaerobic conditions; use a model to describe phenomena using an understanding of the role of photosynthesis or cellular respiration in the cycling of carbon; evaluate a claim about a phenomenon involving interactions in ecosystems using a partial understanding that these interactions maintain relatively consistent numbers and types of organisms under stable conditions, but changing conditions may result in a new ecosystem; identify a solution for reducing impacts of human activities on the environment or biodiversity; and use evidence to describe the role of group behavior on individual and species' chances to survive and reproduce. (LS2)
- Ask a question about a phenomenon to clarify relationships about the role of DNA in chromosomes in coding the instructions for traits passed from parents to offspring; make a claim about phenomena using a partial understanding that inheritable genetic variations may result from new genetic combinations through meiosis, viable errors during replication, or mutations caused by environmental factors; and describe phenomena using an understanding of the variation and distribution of expressed traits in a population. (LS3)
- Communicate scientific information about phenomena using a partial understanding that common ancestry and biological evolution are supported by empirical evidence; use evidence to construct an explanation about phenomena using a partial understanding that the process of evolution primarily results from one or two of the following factors: the potential for a species to increase in number, the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, competition for limited resources, and the proliferation of those organisms that are better able to survive and reproduce in the environment; apply concepts of

statistics or probability to explain phenomena using a partial understanding that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking the trait; explain phenomena using a partial understanding of how natural selection leads to adaptation of populations; use evidence to support claims about phenomena using a partial understanding that changes in environmental conditions may result in one or two of the following: increases in numbers of individuals of some species, the emergence of new species over time, or the extinction of other species; and use a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (LS4)

- Use evidence to develop a model to describe phenomena using a partial understanding of the life span of the Sun or the role of nuclear fusion in the Sun's core to release energy that reaches Earth in the form of radiation; use evidence and a partial understanding of the phenomena of light spectra, motion of distant galaxies, or composition of matter in the universe to construct an explanation of the big bang theory; communicate a scientific idea about a phenomenon using a partial understanding of the way stars produce different elements over their life cycles; use a mathematical or computational representation of phenomena to predict the motion of orbiting objects in the solar system; use evidence of phenomena using a partial understanding of past and current movements of continental and oceanic crust or the theory of plate tectonics to explain the ages of crustal rocks; and apply scientific reasoning or a partial understanding of evidence from ancient Earth materials, meteorites, and other planetary surfaces to describe phenomena about Earth's formation and early history. (ESS1)
- Use a model to describe phenomena using a partial understanding of how Earth's internal and surface processes operate to form continental and ocean floor features; use geoscience data about phenomena to make a claim that one change to Earth's surface can create feedback that causes changes to other Earth systems; develop a model of Earth's interior to describe phenomena using an understanding of the cycling of matter by thermal convection; use a model to describe phenomena using a partial understanding of how variations in the flow of energy into and out of Earth's systems result in changes in climate; conduct an investigation of phenomena related to the properties of water using a partial understanding of water's effects on Earth materials or surface processes; use a quantitative model to describe phenomena using a partial understanding of the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere; and use evidence to make a claim about phenomena using a partial understanding of the simultaneous coevolution of Earth's systems and life on Earth. (ESS2)
- Use evidence to construct an explanation about phenomena using a partial understanding of how the availability of natural resources, occurrence of natural hazards, or changes in climate have influenced human activity; using a partial understanding of cost-benefit ratios, evaluate a design solution for developing, managing, or utilizing energy or mineral resources; use a computational simulation of phenomena to show some of the relationships among management of natural resources, the sustainability of human populations, and biodiversity; using a partial understanding of human impacts on natural systems, describe a technological solution that reduces these impacts; use geoscience data or global climate models of

phenomena to make a forecast of the current rate of climate change or associated future impacts to Earth systems; and use a computational representation to describe phenomena using a partial understanding of the relationships among Earth systems or how those relationships are modified due to human activity. (ESS3)

- Analyze a major global challenge to specify a qualitative or quantitative criterion or constraint for a solution that accounts for a societal need or want; describe one or two ways a complex real-world problem could be broken down into smaller, more manageable problems that could be solved through engineering; explain how a solution to a complex real-world problem meets required criteria or explain one or two trade-offs of the solution; and use a computer simulation to model the impact of a proposed solution to a complex real-world problem with two or three criteria and constraints on interactions within or between systems relevant to the problem. (ETS1)

Level 1

Students at **Level 1** demonstrate evidence of emerging understanding and use of all three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) to make sense of phenomena and/or to design solutions to problems in the physical, life, and Earth and space sciences.