twig Science Grade 6 Suggested Scope and Sequence

	MODULE	STEAM ROLE STORYLINE	PERFORMANCE EXPECTATIONS
VOLUME 1	**Under the Microscope**	Students take on the role of medical students, scrubbing up and rotating through a hospital. By studying symptoms, investigating body systems, and observing microscopic cells, they diagnose patients' mystery maladies.	**MS-LS1-1** Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. **MS-LS1-2** Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. **MS-LS1-3** Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
	CreATe Network	Inspired by the platform "CreATe Network," students identify the assistive technology needs of people with disabilities. Designing and testing their devices, students strive to engineer the perfect solution.	**MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. **MS-LS1-3*** Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
VOLUME 2	**The Great Air Race**	As part of a team, students navigate the skies in a bid to win the Great Air Race. Providing weather reports and routing advice, they strive to reach the next airport in the quickest time... without heading straight into a storm!	**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. **MS-ESS2-5** Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. **MS-PS1-4*** 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. **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.
	Model Earth	Climate models are the backbone of modern climate science. But how are they developed, and why are they used? Students will investigate the factors that affect climate, including atmospheric and oceanic circulation, and develop a global 3-D climate model.	**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. **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. **MS-PS4-2*** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
	Life Through a Lens	For us humans, a lot of our planet is unhabitable. But even in the most extreme environments, from freezing tundras to arid deserts, animals can thrive. As documentary filmmakers, students turn the cameras on these survivors to capture how they do it.	**MS-PS3-3** Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. **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. **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. **MS-LS1-7*** 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. **MS-ETS1-1*** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2*** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3*** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4*** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
VOLUME 3	**North Island Rescue**	Some of New Zealand's unique plants and animals are at risk of extinction. What can we do to save the species? Students explore the genetic and environmental factors that affect growth, and develop an ecosystem survival plan for the North Island pollinators and the plants that rely on them.	**MS-LS1-5** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. **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. **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. **MS-LS1-4*** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. **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.
	Landscape of Fear	Students join ecologists in the field to investigate the landscape of fear, analyzing the behaviors of animals and traits of plants in an environment where species must fight to survive.	**MS-LS1-4** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. **MS-LS1-8** Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. **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.
VOLUME 4	**The Heat Is On**	Over the past century, we've built a world reliant on industrial processes. At the same time, global warming has increased to an unprecedented degree. Students develop an eco-city, taking inspiration from cities tackling climate change.	**MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. **MS-ESS3-5** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. **MS-LS2-4*** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-ETS1-1*** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2*** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
	Emergency Hydration	As the climate warms, natural disasters are likely to get more dangerous and being prepared will be vital. Students design water filtration systems to help communities access clean drinking water when natural disasters strike.	**MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. **MS-ETS1-1*** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2*** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ESS3-2*** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. **MS-ESS3-3*** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

*Supporting PEs

NGSS

Science and Engineering Practices	Crosscutting Concepts	Disciplinary Core Ideas	Environmental Principles and Concepts
SEP-1, SEP-2, SEP-3, SEP-6, SEP-7, SEP-8	CCC-1, CCC-2, CCC-3, CCC-4, CCC-6, CNS-7, CETAS-1	LS1.A	Principle I, Principle II, Principle IV
SEP-1, SEP-2, SEP-4, SEP-7	CCC-4, CCC-6, CNS-7, CETAS-2	LS1.A, ETS1.A, ETS1.B, ETS1.C	
SEP-1, SEP-2, SEP-3, SEP-4, SEP-5, SEP-6, SEP-7, SEP-8	CCC-1, CCC-2, CCC-4, CCC-5	PS1.A, PS3.B, ESS2.C, ESS2.D	Principle I, Principle III
SEP-2, SEP-3, SEP-6, SEP-8	CCC-1, CCC-2, CCC-4, CCC-5, CCC-7	ESS2.C, ESS2.D, PS3.B, PS4.B	Principle I, Principle II, Principle III, Principle IV
SEP-1, SEP-2, SEP-3, SEP-4, SEP-6, SEP-7, SEP-8, CNS-2	CCC-2, CCC-3, CCC-5, CCC-6	PS3.A, PS3.B, PS3.D, LS1.C, ETS1.A, ESS2.C	Principle III
SEP-2, SEP-3, SEP-4, SEP-6, SEP-7, SEP-8	CCC-1	LS1.B, LS3.A, LS3.B, ETS1.B, ETS1.C	Principle III
SEP-1, SEP-2, SEP-3, SEP-4, SEP-6, SEP-7, SEP-8	CCC-1, CCC-2	LS1.B, LS1.D, PS4.C	Principle III
SEP-1, SEP-2, SEP-3, SEP-4, SEP-5, SEP-6, SEP-7, SEP-8	CCC-1, CCC-2, CCC-4, CCC-7, CETAS-2	ESS3.C, ESS3.D, LS2.C, ETS1.A, ETS1.B	Principle I, Principle II, Principle III, Principle IV, Principle V
SEP-1, SEP-2, SEP-3, SEP-4, SEP-7, SEP-8	CCC-2, CCC-6, CETAS-2	ETS1.A, ETS1.B, ETS1.C, ESS3.B, ESS3.C	Principle I, Principle II, Principle III, Principle IV, Principle V

NGSS STANDARDS KEY

SCIENCE AND ENGINEERING PRACTICES

SEP-1 Asking Questions and Defining Problems
SEP-2 Developing and Using Models
SEP-3 Planning and Carrying Out Investigations
SEP-4 Analyzing and Interpreting Data
SEP-5 Using Mathematics and Computational Thinking
SEP-6 Constructing Explanations and Designing Solutions
SEP-7 Engaging in Argument from Evidence
SEP-8 Obtaining, Evaluating, and Communicating Information

CONNECTIONS TO THE NATURE OF SCIENCE

CNS-1 Scientific Investigations Use a Variety of Methods
CNS-2 Scientific Knowledge is Based on Empirical Evidence
CNS-3 Scientific Knowledge is Open to Revision in Light of New Evidence
CNS-4 Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

CROSSCUTTING CONCEPTS

CCC-1 Patterns
CCC-2 Cause and Effect
CCC-3 Scale, Proportion, and Quantity
CCC-4 Systems and System Models
CCC-5 Energy and Matter
CCC-6 Structure and Function
CCC-7 Stability and Change

CONNECTIONS TO ENGINEERING,TECHNOLOGY, AND APPLICATIONS OF SCIENCE

CETAS-1 Interdependence of Science, Engineering, and Technology
CETAS-2 Influence of Engineering, Technology, and Science on Society and the Natural World

CONNECTIONS TO THE NATURE OF SCIENCE

CNS-5 Science is a Way of Knowing
CNS-6 Scientific Knowledge Assumes an Order and Consistency in Natural Systems
CNS-7 Science is a Human Endeavor
CNS-8 Science Addresses Questions About the Natural and Material World

DISCIPLINARY CORE IDEAS

PS1.A Structure and Properties of Matter
PS1.B Chemical Reactions
PS2.A Forces and Motion
PS2.B Types of Interactions
PS3.A Definitions of Energy
PS3.B Conservation of Energy and Energy Transfer
PS3.C Relationship between Energy and Forces
PS3.D Energy in Chemical Processes and Everyday Life
PS4.A Wave Properties
PS4.B Electromagnetic Radiation
PS4.C Information Technologies and Instrumentation

ETS1.A Defining and Delimiting Engineering Problems
ETS1.B Developing Possible Solutions
ETS1.C Optimizing the Design Solution

ESS1.A The Universe and Its Stars
ESS1.B Earth and the Solar System
ESS1.C The History of Planet Earth
ESS2.A Earth's Materials and Systems
ESS2.B Plate Tectonics and Large-Scale System Interactions
ESS2.C The Roles of Water in Earth's Surface Processes
ESS2.D Weather and Climate
ESS3.A Natural Resources
ESS3.B Natural Hazards
ESS3.C Human Impacts on Earth Systems
ESS3.D Global Climate Change

LS1.A Structure and Function
LS1.B Growth and Development of Organisms
LS1.C Organization for Matter and Energy Flow in Organisms
LS1.D Information Processing
LS2.A Interdependent Relationships in Ecosystems
LS2.B Cycles of Matter and Energy Transfer in Ecosystems
LS2.C Ecosystem Dynamics, Functioning, and Resilience
LS3.A Inheritance of Traits
LS3.B Variation of Traits
LS4.A Evidence of Common Ancestry and Diversity
LS4.B Natural Selection
LS4.C Adaptation
LS4.D Biodiversity and Humans

ENVIRONMENTAL PRINCIPLES AND CONCEPTS

Principle I People Depend on Natural Systems
Principle II People Influence Natural Systems
Principle III Natural Systems Change in Ways that People Benefit From and Can Influence
Principle IV There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems
Principle V Decisions Affecting Resources and Natural Systems are Complex and Involve Many Factors

twig Science Grade 7 Suggested Scope and Sequence

	MODULE	STEAM ROLE STORYLINE	PERFORMANCE EXPECTATIONS
VOLUME 5	**The Resource Race**	We've developed technology that has transformed our world, but this wouldn't be possible without resources found within the Earth's crust. Students investigate relationships between human advancement and the planet that sustains it.	**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. **MS-PS1-6*** Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. **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. **MS-ESS2-1*** Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. **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.
	The Plastic Tide	The Earth's oceans are swimming in over 25 million square kilometers of plastic. Students dive deep into the chemistry of materials and the science of recycling, aiming to figure out the problem and find solutions to slow the plastic tide.	**MS-PS1-1** Develop models to describe the atomic composition of simple molecules and extended structures. **MS-PS1-3** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. **MS-PS1-4** 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. **MS-LS2-3*** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. **MS-LS2-4*** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-ETS1-1*** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2*** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
VOLUME 6	**Volcano Hunters**	Students investigate what makes volcanoes tick before analyzing real-life data from active volcanoes, assessing threat levels, and devising a plan to protect people from the dangers of eruptions.	**MS-ESS2-1** Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. **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. **MS-PS1-2*** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **MS-PS3-1*** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
	Dinosaur Trail	Working with the curators of a prehistoric learning center, students investigate fossils and the geoscience processes that create and reveal them as they construct a dynamic new exhibit—the Dinosaur Trail.	**MS-ESS2-2** Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. **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. **MS-PS1-2*** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **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.
VOLUME 7	**Science on the Main Stage**	Students take on the role of special effects technicians in the music industry, creating fog, colored fire, glitter cannons, LED lights, shimmering showers, and a stunning fireworks finale.	**MS-PS1-2** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **MS-PS1-5** 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. **MS-LS1-8*** Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. **MS-PS1-1*** Develop models to describe the atomic composition of simple molecules and extended structures. **MS-PS1-4*** 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.
	Turtle SOS	As turtles prepare to hatch and make their way to the ocean, a dangerous oil spill awaits. Can students design a solution to keep the eggs at the right temperature and transport them to cleaner waters?	**MS-PS1-6** Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. **MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. **MS-ETS1-2*** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-PS1-2*** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
VOLUME 8	**Future Food**	What will we be eating in 2050? And how will the produce be grown? Investigating new technologies, food sources, and production methods, students reimagine mealtimes for a future generation.	**MS-LS1-6** 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. **MS-LS1-7** 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. **MS-PS1-2*** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **MS-PS1-5*** 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. **MS-LS1-2*** Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
	A Place Called Home	Students join scientists at the SAFE Project in Borneo to explore how changes to ecosystems can affect living things, and discover how to manage and repair an altered ecosystem.	**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. **MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. **MS-LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. **MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **MS-ESS3-3*** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. **MS-ESS3-5*** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the=past century.
	The Green Monster	Students become environmental engineers working on the banks of Lake Erie, developing a new and improved fertilizer solution that fulfills the needs of the community without harming the environment.	**MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3*** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4*** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. **MS-ESS2-1*** Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. **MS-ESS3-3*** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

*Supporting PEs

NGSS

Science and Engineering Practices	Crosscutting Concepts	Disciplinary Core Ideas	Environmental Principles and Concepts
SEP-1, SEP-2, SEP-4, SEP-6, SEP-8	CCC-1, CCC-2, CCC-3, CCC-5, CNS-8, CETAS-2	ESS1.C, ESS2.A, ESS3.A, ESS3.C, PS1.B	Principle I, Principle II, Principle III, Principle IV, Principle V
SEP-1, SEP-2, SEP-3, SEP-4, SEP-6, SEP-8	CCC-2, CCC-3, CCC-4, CCC-6, CCC-7, CETAS-1, CETAS-2	PS1.A, PS3.A, PS1.B, LS2.B, LS2.C, ETS1.A, ETS1.B	Principle I, Principle II, Principle III, Principle IV, Principle V
SEP-1, SEP-2, SEP-3, SEP-4, SEP-6, SEP-7, SEP-8	CCC-1, CCC-2, CCC-3, CCC-6, CCC-7	PS1.A, PS3.A, ESS2.A, ESS3.B	Principle V
SEP-2, SEP-3, SEP-4, SEP-6, SEP-7, SEP-8, CNS-3	CCC-1, CCC-2, CCC-3, CCC-7	PS1.A, ESS1.C, ESS2.A, ESS2.B, ESS2.C	Principle II, Principle IV
SEP-2, SEP-3, SEP-4, SEP-5, SEP-6, SEP-7, SEP-8, CNS-2, CNS-4	CCC-1, CCC-2, CCC-5	PS1.A, PS1.B, LS1.D, ESS2.C	
SEP-1, SEP-2, SEP-3, SEP-4, SEP-6, SEP-7, SEP-8	CCC-2, CCC-4, CCC-5, CETAS-2	PS1.B, ETS1.A, ETS1.B, ETS1.C	Principle II, Principle III, Principle IV, Principle V
SEP-2, SEP-3, SEP-4, SEP-6, SEP-8, CNS-2	CCC-1, CCC-2, CCC-3, CCC-4, CCC-5, CETAS-2	LS1.A, LS1.C, LS2.A, ESS3.A, PS1.A, PS3.D	Principle I, Principle II, Principle III, Principle IV, Principle V
SEP-1, SEP-2, SEP-4, SEP-5, SEP-6, SEP-7, SEP-8, CNS-2	CCC-1, CCC-2, CCC-5, CCC-7, CNS-6, CNS-8, CETAS-2	LS2.A, LS2.B, LS2.C, LS4.D, ESS3.C, ESS3.D, ETS1.A, ETS1.B	Principle I, Principle II, Principle III, Principle IV, Principle V
SEP-1, SEP-2, SEP-3, SEP-4, SEP-6, SEP-7	CCC-2, CCC-5, CCC-7, CETAS-2	ETS1.A, ETS1.B, ETS1.C, ESS2.A, ESS3.C	Principle I, Principle II, Principle III, Principle IV, Principle V

NGSS STANDARDS KEY

SCIENCE AND ENGINEERING PRACTICES

SEP-1 Asking Questions and Defining Problems
SEP-2 Developing and Using Models
SEP-3 Planning and Carrying Out Investigations
SEP-4 Analyzing and Interpreting Data
SEP-5 Using Mathematics and Computational Thinking
SEP-6 Constructing Explanations and Designing Solutions
SEP-7 Engaging in Argument from Evidence
SEP-8 Obtaining, Evaluating, and Communicating Information

CONNECTIONS TO THE NATURE OF SCIENCE

CNS-1 Scientific Investigations Use a Variety of Methods
CNS-2 Scientific Knowledge is Based on Empirical Evidence
CNS-3 Scientific Knowledge is Open to Revision in Light of New Evidence
CNS-4 Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

CROSSCUTTING CONCEPTS

CCC-1 Patterns
CCC-2 Cause and Effect
CCC-3 Scale, Proportion, and Quantity
CCC-4 Systems and System Models
CCC-5 Energy and Matter
CCC-6 Structure and Function
CCC-7 Stability and Change

CONNECTIONS TO ENGINEERING,TECHNOLOGY, AND APPLICATIONS OF SCIENCE

CETAS-1 Interdependence of Science, Engineering, and Technology
CETAS-2 Influence of Engineering, Technology, and Science on Society and the Natural World

CONNECTIONS TO THE NATURE OF SCIENCE

CNS-5 Science is a Way of Knowing
CNS-6 Scientific Knowledge Assumes an Order and Consistency in Natural Systems
CNS-7 Science is a Human Endeavor
CNS-8 Science Addresses Questions About the Natural and Material World

DISCIPLINARY CORE IDEAS

PS1.A Structure and Properties of Matter
PS1.B Chemical Reactions
PS2.A Forces and Motion
PS2.B Types of Interactions
PS3.A Definitions of Energy
PS3.B Conservation of Energy and Energy Transfer
PS3.C Relationship between Energy and Forces
PS3.D Energy in Chemical Processes and Everyday Life
PS4.A Wave Properties
PS4.B Electromagnetic Radiation
PS4.C Information Technologies and Instrumentation

ETS1.A Defining and Delimiting Engineering Problems
ETS1.B Developing Possible Solutions
ETS1.C Optimizing the Design Solution

ESS1.A The Universe and Its Stars
ESS1.B Earth and the Solar System
ESS1.C The History of Planet Earth
ESS2.A Earth's Materials and Systems
ESS2.B Plate Tectonics and Large-Scale System Interactions
ESS2.C The Roles of Water in Earth's Surface Processes
ESS2.D Weather and Climate
ESS3.A Natural Resources
ESS3.B Natural Hazards
ESS3.C Human Impacts on Earth Systems
ESS3.D Global Climate Change

LS1.A Structure and Function
LS1.B Growth and Development of Organisms
LS1.C Organization for Matter and Energy Flow in Organisms
LS1.D Information Processing
LS2.A Interdependent Relationships in Ecosystems
LS2.B Cycles of Matter and Energy Transfer in Ecosystems
LS2.C Ecosystem Dynamics, Functioning, and Resilience
LS3.A Inheritance of Traits
LS3.B Variation of Traits
LS4.A Evidence of Common Ancestry and Diversity
LS4.B Natural Selection
LS4.C Adaptation
LS4.D Biodiversity and Humans

ENVIRONMENTAL PRINCIPLES AND CONCEPTS

Principle I People Depend on Natural Systems
Principle II People Influence Natural Systems
Principle III Natural Systems Change in Ways that People Benefit From and Can Influence
Principle IV There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems
Principle V Decisions Affecting Resources and Natural Systems are Complex and Involve Many Factors

twig Science Grade 8 Suggested Scope and Sequence

	MODULE	STEAM ROLE STORYLINE	PERFORMANCE EXPECTATIONS
VOLUME 9	**Ocean Powered**	Students take on the role of engineering advisers, researching, developing, and testing Ocean Energy Converter (OEC) devices that use powerful ocean forces to transfer energy and generate electricity.	**MS-PS2-2** 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. **MS-PS3-1** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. **MS-ETS1-1*** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2*** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3*** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4*** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
	Asteroid Alert!	What are the odds of an asteroid striking the Earth? Could the Moon ever fall out of the sky? Students look to the Solar System to find out, exploring the characteristics of space objects and the threats they pose.	**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. **MS-ESS1-2** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. **MS-ESS1-3** Analyze and interpret data to determine scale properties of objects in the solar system. **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. **MS-PS2-4*** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. **MS-PS2-5*** 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.
VOLUME 10	**Collision Course**	What happens when two players collide? Students study sports injuries to understand the science behind collisions, using models and analyzing data to design customized helmets that minimize the risk of concussions and keep athletes safe.	**MS-PS2-1** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-4** 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. **MS-ETS1-1*** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-3*** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-LS1-3*** Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
	Movie Magic	Lights, camera, action! Students work as science advisers with a movie production company, designing hoverboards, modeling football on Mars, and crafting the perfect stunt fall—creating movie magic that's rooted in real-world physics.	**MS-PS2-3** Ask questions about data to determine the factors that affect the strength of electrical and magnetic forces. **MS-PS2-4** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. **MS-PS2-5** 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. **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. **MS-ESS1-2*** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. **MS-ESS1-3*** Analyze and interpret data to determine scale properties of objects in the solar system.
VOLUME 11	**Are They Among Us?**	Students investigate the rich and complex history of life on Earth as they uncover evidence in the fossil record and analyze organisms to determine their ancient relatives.	**MS-LS4-1** Analyze and interpret data for patterns in the fossil record that documents 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. **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. **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. **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. **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.
	Survival Stories	Students explore how we humans have survived in the face of the challenges presented by the world around us, using genetics as a lens to tell stories from our past and explore the possibilities of our future.	**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. **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. **MS-LS4-5** Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. **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. **MS-ETS1-1*** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-LS1-1*** Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. **MS-LS1-5*** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. **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.
VOLUME 12	**Amazon of the Oceans**	Students analyze the impacts of population growth, resource use, and human activity on the environment as they explore the biodiverse Coral Triangle. They create a social media campaign to help protect this important environment.	**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. **MS-LS2-4*** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-ESS3-3*** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
	Into the Abyss	Over 80% of our oceans are unmapped. Students discover how waves can be used to learn more about the ocean, and plan a submarine expedition into the abyss to reveal the secrets of the sea using sonar techniques.	**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. **MS-PS4-2** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. **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.
	Animal Tracks	Wildlife monitoring is essential for understanding animal movement patterns and populations. Working alongside wildlife ecologists, students investigate how data can be transmitted between different monitoring devices and determine which approaches provide the most accurate data.	**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. **MS-LS1-4*** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. **MS-ETS1-2*** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
	The Bees' Needs	Students work as ecosystem engineers to create microhabitats for honeybees. They identify the criteria and constraints of a successful beehive design, develop 2-D models, and iterate 3-D models.	**MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-2*** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **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. **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. **MS-LS2-4*** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

*Supporting PEs

NGSS

Science and Engineering Practices	Crosscutting Concepts	Disciplinary Core Ideas	Environmental Principles and Concepts
SEP-2, SEP-3, SEP-4, SEP-6, SEP-7, SEP-8, CNS-2, CNS-4	CCC-1, CCC-2, CCC-3, CCC-4, CCC-5, CCC-6, CCC-7, CNS-8	PS2.A, PS3.A, PS3.B, PS3.C, ETS1.A, ETS1.B, ETS1.C	Principle II, Principle III, Principle IV, Principle V
SEP-2, SEP-4, SEP-6, SEP-8	CCC-1, CCC-2, CCC-3, CCC-4, CNS-6, CETAS-1	PS2.B, ESS1.A, ESS1.B, ESS1.C	
SEP-1, SEP-2, SEP-4, SEP-6, SEP-7	CCC-1, CCC-2, CCC-4, CCC-5, CCC-6, CETAS-2	PS2.A, LS1.A, ETS1.A, ETS1.B, ETS1.C	
SEP-1, SEP-2, SEP-3, SEP-4, SEP-5, SEP-6, SEP-7, SEP-8, CNS-2	CCC-1, CCC-2, CCC-4, CCC-6, CCC-7	PS2.B, PS3.A, PS3.C, ESS1.B	
SEP-1, SEP-2, SEP-4, SEP-6, SEP-8, CNS-2	CCC-1, CCC-3, CNS-6	LS4.A, LS4.B, ESS1.C	
SEP-2, SEP-4, SEP-5, SEP-6, SEP-7, SEP-8	CCC-1, CCC-2, CCC-3, CCC-6, CCC-7, CNS-8, CETAS-1	LS1.A, LS1.B, LS3.A, LS3.B, LS4.B, LS4.C, EST1.A, ETS1.B	
SEP-2, SEP-4, SEP-5, SEP-7, SEP-8	CCC-2, CCC-5, CCC-7, CNS-5, CNS-8, CETAS-2	LS2.B, LS2.C, ESS3.C	Principle I, Principle II, Principle III, Principle IV, Principle V
SEP-1, SEP-2, SEP-3, SEP-4, SEP-5, SEP-6, SEP-7, SEP-8, CNS-2	CCC-1, CCC-2, CCC-5, CCC-6	PS4.A, PS4.B, LS4.B, LS4.C	Principle III
SEP-1, SEP-2, SEP-3, SEP-4, SEP-5, SEP-8, CNS-3	CCC-1, CCC-2, CCC-3, CCC-6, CCC-7, CNS-7, CETAS-2	PS4.C, LS1.B, ETS1.B	Principle II, Principle III, Principle IV, Principle V
SEP-1, SEP-2, SEP-4, SEP-6, SEP-7	CCC-2, CETAS-2	LS2.A, LS2.C, ETS1.A, ETS1.B, ETS1.C	Principle I, Principle II, Principle III, Principle IV, Principle V

NGSS STANDARDS KEY

SCIENCE AND ENGINEERING PRACTICES

SEP-1 Asking Questions and Defining Problems
SEP-2 Developing and Using Models
SEP-3 Planning and Carrying Out Investigations
SEP-4 Analyzing and Interpreting Data
SEP-5 Using Mathematics and Computational Thinking
SEP-6 Constructing Explanations and Designing Solutions
SEP-7 Engaging in Argument from Evidence
SEP-8 Obtaining, Evaluating, and Communicating Information

CONNECTIONS TO THE NATURE OF SCIENCE

CNS-1 Scientific Investigations Use a Variety of Methods
CNS-2 Scientific Knowledge is Based on Empirical Evidence
CNS-3 Scientific Knowledge is Open to Revision in Light of New Evidence
CNS-4 Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

CROSSCUTTING CONCEPTS

CCC-1 Patterns
CCC-2 Cause and Effect
CCC-3 Scale, Proportion, and Quantity
CCC-4 Systems and System Models
CCC-5 Energy and Matter
CCC-6 Structure and Function
CCC-7 Stability and Change

CONNECTIONS TO ENGINEERING,TECHNOLOGY, AND APPLICATIONS OF SCIENCE

CETAS-1 Interdependence of Science, Engineering, and Technology
CETAS-2 Influence of Engineering, Technology, and Science on Society and the Natural World

CONNECTIONS TO THE NATURE OF SCIENCE

CNS-5 Science is a Way of Knowing
CNS-6 Scientific Knowledge Assumes an Order and Consistency in Natural Systems
CNS-7 Science is a Human Endeavor
CNS-8 Science Addresses Questions About the Natural and Material World

DISCIPLINARY CORE IDEAS

PS1.A Structure and Properties of Matter
PS1.B Chemical Reactions
PS2.A Forces and Motion
PS2.B Types of Interactions
PS3.A Definitions of Energy
PS3.B Conservation of Energy and Energy Transfer
PS3.C Relationship between Energy and Forces
PS3.D Energy in Chemical Processes and Everyday Life
PS4.A Wave Properties
PS4.B Electromagnetic Radiation
PS4.C Information Technologies and Instrumentation

ETS1.A Defining and Delimiting Engineering Problems
ETS1.B Developing Possible Solutions
ETS1.C Optimizing the Design Solution

ESS1.A The Universe and Its Stars
ESS1.B Earth and the Solar System
ESS1.C The History of Planet Earth
ESS2.A Earth's Materials and Systems
ESS2.B Plate Tectonics and Large-Scale System Interactions
ESS2.C The Roles of Water in Earth's Surface Processes
ESS2.D Weather and Climate
ESS3.A Natural Resources
ESS3.B Natural Hazards
ESS3.C Human Impacts on Earth Systems
ESS3.D Global Climate Change

LS1.A Structure and Function
LS1.B Growth and Development of Organisms
LS1.C Organization for Matter and Energy Flow in Organisms
LS1.D Information Processing
LS2.A Interdependent Relationships in Ecosystems
LS2.B Cycles of Matter and Energy Transfer in Ecosystems
LS2.C Ecosystem Dynamics, Functioning, and Resilience
LS3.A Inheritance of Traits
LS3.B Variation of Traits
LS4.A Evidence of Common Ancestry and Diversity
LS4.B Natural Selection
LS4.C Adaptation
LS4.D Biodiversity and Humans

ENVIRONMENTAL PRINCIPLES AND CONCEPTS

Principle I People Depend on Natural Systems
Principle II People Influence Natural Systems
Principle III Natural Systems Change in Ways that People Benefit From and Can Influence
Principle IV There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems
Principle V Decisions Affecting Resources and Natural Systems are Complex and Involve Many Factors