Course Name:	7/8 Science Course B		
Credits:	n/a		
Prerequisites:	n/a		
Description:	Course covering aspects within Physical, Earth and Life Sciences.		
Academic Standards:	Next-Generation Science Standards		
Units:	**Unit Length:**	**Unit Standards:**	**Unit Outcomes:**
Population and Ecosystems	approximately 59	MS-LS1-6, MS-LS1-7, MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4, MS-LS2-5, MS-ESS3-3, MS-ESS3-4, MS-ETS1-1, MS-ETS1-2	In an 8-week investigation, students raise milkweed bugs in a supportive habitat to study the insect’s reproductive biology. The information from this study is used to study milkweed-bug population dynamics. Students use ecosystem sorting cards to reflect on organizing concepts in ecology and develop the vocabulary associated with those concepts. Through a Jane Goodall video, students become familiar with a specific population study of chimpanzees. Students are introduced to one of ten ecoscenarios representing major biomes of Earth that will be studied throughout the course. Students use Mono Lake, an important alkaline lake, as a simple ecosystem case study. Students study the functional roles of populations to construct a food web. Students construct aquatic and terrestrial ecosystems in the classroom and observe them over time to understand ecosystem interactions. They use a scientific log to observe, describe, and monitor changes in biotic and abiotic factors. Students explore the effect of light on photosynthesis by studying wheat plants. Students learn that through photosynthesis, producers increase the biomass of an ecosystem. Students investigate the producers in specific ecosystems and identify their roles. Students model and measure the energy transferred from food. Students learn how energy provided by producers is used by all organisms. They explore how food energy moves from one trophic level to another through feeding relationships. Students simulate feeding relationships and determine what is needed to sustain a food chain. They investigate the role of decomposers in ecosystems. Students explore some of the variables in an ecosystem that limit population size. Based on their milkweed-bug study, they predict what the population would be in 12 months. Students use simulations to explore population interactions and outcomes. Students explore the importance of biodiversity on the health of the ecosystem. They investigate how humans have interacted with the ecosystem and put stresses on biodiversity. Students then learn how humans can reverse these stresses and help restore ecosystems. Students return to their ecoscenarios and use the knowledge developed in previous investigations to analyze the effects of human interactions in their ecosystem. They are given several engineering solutions and evaluate which they feel is the best solution to preserve or restore the ecosystem.

Waves	approximately 35	MS-PS4-1, MS-PS4-2, MS-PS4-3, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4	Students measure their pulse under different circumstances to think about frequency. They create waves using metal springs and use these simple waves to explore the fundamental properties of waves: wavelength, frequency, and amplitude. Students learn about wave energy and compare energy in waves with different properties. Students look at an engineering failure and consider the work engineers must do to achieve a successful design. They use these ideas to develop a chamber that can effectively block sound waves. Students explore properties of light waves. They start by using mirrors to explore reflection. Students use spectroscopes to analyze spectra of visible light and learn more about the electromagnetic spectrum. They use filters to change the spectrum of a light source and to learn about color. They determine how refraction changes the path of light rays as they travel between media. Students learn how information can be encoded and sent as digital waves to transfer large amounts of information efficiently over large distances. They test properties of fiber optic cables to develop an understanding of how total internal reflection allows data transfer by light. Students learn how data is encoded and sent as modulated waves to a recipient for demodulation. Students create digital waves and develop an understanding of how digital waves enable modern communications.
Gravity and Kinetic Energy	approximately 38	MS-PS2-1, MS-PS2-2, MS-PS2-4, MS-PS2-5, MS-PS3-1, MS-PS3-2, MS-PS3-5, MS-ESS1-2, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4	Students see an unprotected “bean brain” fall to the floor and start to think about speed, acceleration, energy transfer, and collisions. They walk along two interval tracks to collect data about speed. After graphing their results, they conclude that the slope of a graph of distance versus time is related to the speed. They then walk along a different interval track and discover that the speed required is not constant. They graph their results to learn about acceleration. Finally, students observe a ball dropping and complete a detailed analysis of its motion. They determine that the ball is not falling at a constant speed, but accelerating. They calculate the rate and compare it to the acceleration of gravity, to develop a working definition of gravity. Students use spring scales to learn about the difference between mass and weight. They compare mass and weight on different planets, then refine their definition of gravity. Students learn about Newton’s second law of motion, which describes the relationship between mass, force, and acceleration. Students roll marbles down a ramp system to collide with plastic cubes. They gather data about the cubes’ motion to make inferences about kinetic and potential energy. Students do an activity in which they review data from different collision scenarios. They analyze the data in two ways to draw conclusions about the effect of mass and speed on collisions. Finally, students experiment with horizontal collisions, learn more about Newton’s laws, and consider the implications in various situations. Students view a video that introduces the physics concept of impulse. They learn that increasing the time it takes for an object to change speed in a collision results in less force being applied to the object. Using this principle, students design a protective helmet for a model head. After several iterative designs, they share results as a class and discuss the engineering design process. To finish the course, students review big ideas and create a list of remaining physics questions. Students work together to answer questions and prepare for the Posttest.

Earth History	approximately 64	MS-ESS1-4, MS-ESS2-1, MS-ESS2-2, MS-ESS2-3, MS-ESS3-1, MS-ESS3-2, MS-ESS3-3, MS-ESS3-4, MS-ESS3-5, MS-LS4-1	Earth Is Rock uses the anchor phenomenon of the Grand Canyon to introduce students to the study of the landforms and rocks that make up Earth’s crust. Through observations of aerial images of Earth’s surface, sedimentary rock samples, and images from the Grand Canyon, students begin developing awareness about the complexity of Earth’s crust and how geologists study it by trying to answer the question “What is the story of this place?” In Weathering and Erosion students explore the phenomena of earth material movement over the surface of Earth. Students observe a stream table to discover how water can erode sediments from one location and deposit the sorted sediments in a basin downstream. They model how rocks weather and what happens to sediments. Students also consider how soil forms. In Deposition, students investigate the phenomenon of the variety of sedimentary rocks on Earth. They look closely at the processes by which bedrock that is weathered and eroded ends up deposited in basins. There, favorable conditions can turn the sediments into sedimentary rock. Students consider how evidence in sedimentary rocks can lead to inferences about the ancient environments in which they formed. In Fossils and Past Environments, students experience the phenomenon of fossils. Students become familiar with the geologic time scale to understand how old fossils are and begin to comprehend the enormous spans of time that are described by geologic time. They use fossils to put the history of the Grand Canyon into the geologic time scale. Igneous Rocks presents students with new rock samples from a new location. It leads to an investigation of the relationship between crystal size and the formation of igneous rocks. The formation of igneous rocks is the phenomenon investigated by students. Volcanoes and Earthquakes provides engaging phenomena to investigate and gives students the opportunity to discover a pattern of geologic activity. Subduction, convection, and the theory of crustal plate tectonics are introduced to explain continental drift, plate boundary interactions, and the patterns of volcanoes and earthquakes. Mountains and Metamorphic Rocks builds on the phenomena of earthquakes and volcanoes by focusing on new landforms—mountains. Students investigate the interactions at plate boundaries that form mountains and metamorphic rocks, leading students to consider the rock cycle. In Geo Scenarios, students apply prior knowledge from the Earth History Course and new, site-specific information to develop a geologic story of a place or process. Students are introduced to four sites across the United States— four phenomena. Each team of students researches the story of one of those places, the processes that shaped it, and the implications of the story for human society. What Is Earth’s Story? challenges students to put together what they have learned about Earth’s geologic history and to use their knowledge to finish telling the story of the phenomenal Grand Canyon.

Unit Name: **Populations and Ecosystems**	**Length:** approximately 59
Standards: MS-LS1-6, MS-LS1-7, MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4, MS-LS2-5, MS-ESS3-3, MS-ESS3-4, MS-ETS1-1, MS-ETS1-2	**Outcomes:** In an 8-week investigation, students raise milkweed bugs in a supportive habitat to study the insect's reproductive biology. The information from this study is used to study milkweed-bug population dynamics in Investigation 7. Students use ecosystem sorting cards to reflect on organizing concepts in ecology and develop the vocabulary associated with those concepts. Through a Jane Goodall video, students become familiar with a specific population study of chimpanzees. Students are introduced to one of ten ecoscenarios representing major biomes of Earth that will be studied throughout the course. Students use Mono Lake, an important alkaline lake, as a simple ecosystem case study. Students study the functional roles of populations to construct a food web. Students construct a food web for their ecoscenario. Students construct aquatic and terrestrial ecosystems in the classroom and observe them over time to understand ecosystem interactions. They use a scientific log to observe, describe, and monitor changes in biotic and abiotic factors. Students explore the effect of light on photosynthesis by studying wheat plants. Students learn that through photosynthesis, producers increase the biomass of an ecosystem. Students investigate the producers in specific ecosystems and identify their roles. Students model and measure the energy transferred from food. Students learn how energy provided by producers is used by all organisms. They explore how food energy moves from one trophic level to another through feeding relationships. Students simulate feeding relationships and determine what is needed to sustain a food chain. They investigate the role of decomposers in ecosystems. Students explore some of the variables in an ecosystem that limit population size. Based on their milkweed-bug study, they predict what the population would be in 12 months. Students use simulations to explore population interactions and outcomes. Students explore the importance of biodiversity on the health of the ecosystem. They investigate how humans have interacted with the ecosystem and put stresses on biodiversity. Students then learn how humans can reverse these stresses and help restore ecosystems. Students return to their ecoscenarios and use the knowledge developed in previous investigations to analyze the effects of human interactions in their ecosystem. They are given several engineering solutions and evaluate which they feel is the best solution to preserve or restore the ecosystem.

Essential Questions:	**Learning Targets:**
What does a population of milkweed bugs need to survive in a classroom? What needs to be considered when building a habitat for milkweed bugs? How do milkweed bugs reproduce and grow? What is the relationship between individuals, populations, communities, and abiotic factors in an ecosystem? How is the milkweed-bug-habitat study similar to and different from Jane Goodall's population study? What are the defining characteristics of your ecosystem? What are the different biotic and abiotic components of the Mono Lake ecosystem? How do the organisms at Mono Lake interact? How do the organisms in your ecoscenario interact? What abiotic factors should be considered when setting up terrestrial and aquatic habitats? What interactions are likely for the organisms in the mini habitat? What changes have taken place in the terrariums and the class aquariums? What is the effect of light on producers? What do producers need to grow and increase biomass? What are the roles of specific producers in the ecosystem? How can we model and measure energy transfer from food? What are the kinds of work you do that require energy? What is needed to sustain a food chain? How does biomass and energy flow through an ecosystem? What happens to the energy stored in the biomass of an organism when it does? How many milkweed bugs could be in your habitat at the end of a year? What are the limiting factors that affect algae and brine shrimp populations at Mono Lake? How does predicted population growth compared to actual population growth? Why is biodiversity important in an ecosystem? What can happen when a species is introduced to an ecosystem? What impact have people had on Mono Lake? How have humans affected your ecoscenario, and what efforts have humans made to lessen this impact?	Students will learn that: •an organism is any living thing. •an organism's habitat is where it lives -- the place where it can meet all of its requirements for life. •a kind of organism that is different from all other kinds of organisms is called a species. •a population is all the individuals of a species in an area at a specified time. •an individual is one single organism; a community is all the interacting populations in a specified area. •an ecosystem is a system of interacting organisms and nonliving factors in a specified area. •biotic factors are living factors in an ecosystem; abiotic factors are nonliving factors. •ecosystems have different sets of biotic and abiotic factors. •biomes are large areas on Earth with similar abiotic factors. •the Mono Lake alkaline-lake ecosystem is defined by the interactions among the organisms and abiotic factors. •the path that food takes as one organism is eaten by another is a food chain. •the feeding relationships in an ecosystem can be represented as a food web. •all ecosystems are defined by the interactions among the organisms and abiotic factors that exist in the region. •an aquatic ecosystem functions in water. •a terrestrial ecosystem functions on land. •organisms depend on the abiotic elements in their ecosystem. •photosynthesis is the process by which energy-rich molecules are made from water, carbon dioxide, and light. •photosynthesis produces potential energy and aerobic cellular respiration transfers usable energy to organisms. •producers increase the biomass of an ecosystem through photosynthesis; ecosystems are defined by their producers. •food is energy-rich organic matter that organisms need to conduct their life processes. •every activity undertaken by living organisms involves expenditure of energy. •feeding relationships identify trophic roles. •biomass moves through an ecosystem from one trophic level to the next; only a small fraction of the biomass consumed at a level is used to produce growth (biomass) at that level; most of the biomass consumed is used for energy and much is lost to the environment. •decomposers recycle food molecules to basic particles for use by organisms in the ecosystem. •reproductive potential is the theoretical unlimited growth of a population over time. •a limiting factor is any biotic or abiotic component of the ecosystem that controls the size of a population. •biodiversity is the variety of organisms in an ecosystem. •a biodiversity index is one measure of the health of an ecosystem, and its ability to recover from stress. In a sustainable ecosystem, the system is resilient to change. •introduced species compete with native species in an ecosystem. •if an introduced species has no predators in the new ecosystem, it can thrive and become invasive. •humans affect ecosystems in both positive and negative ways. •humans rely on ecosystems for ecosystem services (provisioning, regulating, cultural, and supporting services). •ecosystems are dynamic systems of complex interactions. •disruptions to abiotic factors in ecosystems can cause shifts in populations and changes to ecosystem sustainability. •changes in ecosystems can affect services essential to humans. •solutions can be engineered to mitigate human impact.

Topic 1: **Milkweed Bugs**	**Length:** 4 sessions
Standard(s): MS-LS2-1	**Academic Vocabulary:** clutch, habitat, inference, instar, molt, nymph, observation, organism, population, species
Lesson Frame: Introducing Milkweed Bugs	We will:
	I will:
Lesson Frame: Milkweed-Bug Habitat	We will:
	I will:
Lesson Frame: Observing Milkweed-Bug Habitats	I will:
	We will:
Essential Questions: •What does a population of milkweed bugs need to survive in a classroom? •What needs to be considered when building a habitat for milkweed bugs? •How do milkweed bugs reproduce and grow?	**Outcomes:** In an 8-week investigation, students raise milkweed bugs in a supportive habitat to study the insect’s reproductive biology. The information from this study is used to study milkweed-bug population dynamics in Investigation 7.
Performance Tasks: •Construct a suitable habitat for milkweed bugs and study their reproductive potential •Observe events and changes that yield information about the life cycle of an insect •Document the sequence of changes that constitute the milkweed bug's life cycle	**Learning Targets:** Students will learn that: •an organism is any living thing. •an organism's habitat is where it lives -- the place where it can meet all of its requirements for life. •a kind of organism that is different from all other kinds of organisms is called a species. •a population is all the individuals of a species in an area at a specified time.
Topic 2: **Sorting Out Life**	**Length:** 7 sessions
Standard(s): MS-LS2-1, MS-LS2-2	**Academic Vocabulary:** abiotic, biome, biotic, community, controlled experiment, ecosystem, ecosystem service, individual, observational study, population, population study
Lesson Frame: Ecosystem Card Sort	We will:
	I will:
Lesson Frame: Video Population Study	We will:
	I will:
Lesson Frame: Ecoscenarios	I will:
	We will:
Essential Questions: •What is the relationship between individuals, populations, communities, and abiotic factors in an ecosystem? •How is the milkweed-bug-habitat study similar to and different from Jane Goodall's population study? •What are the defining characteristics of your ecosystem?	**Outcomes:** Students use ecosystem sorting cards to reflect on organizing concepts in ecology and develop the vocabulary associated with those concepts. Through a Jane Goodall video, students become familiar with a specific population study of chimpanzees. Students are introduced to one of ten ecoscenarios representing major biomes of Earth that will be studied throughout the course.

Performance Tasks: •Analyze and categorize cards using evidence to determine which represent individuals, populations, communities, and ecosystems •Identify biotic and abiotic factors in an ecosystem	**Learning Targets:** Students will learn that: •an individual is one single organism; a community is all the interacting populations in a specified area. •an ecosystem is a system of interacting organisms and nonliving factors in a specified area. •biotic factors are living factors in an ecosystem; abiotic factors are nonliving factors. •ecosystems have different sets of biotic and abiotic factors. •biomes are large areas on Earth with similar abiotic factors.
Topic 3: **Mono Lake**	**Length:** 7 sessions
Standard(s): MS-LS2-2, LS-LS2-3	**Academic Vocabulary:** decomposer, detritivore, detritus, first-level consumer, food chain, food web, migratory, primary consumer, producer, secondary consumer, second-level consumer, tertiary consumer, third-level consumer
Lesson Frame: A Visit to Mono Lake	We will: I will:
Lesson Frame: Mono Lake Food Web	We will: I will:
Lesson Frame: Ecoscenario Food Webs	We will: I will:
Essential Questions: •What are the different biotic and abiotic components of the Mono Lake ecosystem? •How do the organisms at Mono Lake interact? •How do the organisms in your ecoscenario interact?	**Outcomes:** Students use Mono Lake, an important alkaline lake, as a simple ecosystem case study. Students study the functional roles of populations to construct a food web. Students construct a food web for their ecoscenario.
Performance Tasks: •Research the functional roles of organisms in the Mono Lake ecosystem in order to construct a food web •Develop a model known as a food web to represent feeding relationships between populations •Construct explanations about the interactions of an ecosystem in terms of functional roles	**Learning Targets:** Students will Learn that: •the Mono Lake alkaline-lake ecosystem is defined by the interactions among the organisms and abiotic factors. •the path that food takes as one organism is eaten by another is a food chain. •the feeding relationships in an ecosystem can be represented as a food web. •all ecosystems are defined by the interactions among the organisms and abiotic factors that exist in the region.
Topic 4: **Mini Habitats**	**Length:** 4 sessions
Standard(s): MS-LS2-1, MS-LS2-4	**Academic Vocabulary:** aquatic, predator, prey, terrestrial
Lesson Frame: The Physical Environment	We will: I will:
Lesson Frame: Introducing Life	We will: I will:
Lesson Frame: Observing Mini Habitats	We will: I will:

Essential Questions: •What abiotic factors should be considered when setting up terrestrial and aquatic habitats? • What interactions are likely for the organisms in the mini habitat? •What changes have taken place in the terrariums and the class aquariums?	**Outcomes:** Students construct aquatic and terrestrial ecosystems in the classroom and observe them over time to understand ecosystem interactions. They use a scientific log to observe, describe, and monitor changes in biotic and abiotic factors.
Performance Tasks: •Assemble the abiotic elements of an aquatic and a terrestrial mini habitat as models of natural habitats •Introduce organisms into aquatic and terrestrial mini habitats •Collect and analyze data over time, using a scientific log and observational drawings to record interactions and changes in mini habitats •Develop a model in the form of a food web for each mini habitat	**Learning Targets:** Students will Learn that: •an aquatic ecosystem functions in water. •a terrestrial ecosystem functions on land. •organisms depend on the abiotic elements in their ecosystem.
Topic 5: **Producers**	**Length:** 8 sessions
Standard(s): MS-LS1-6, MS-LS1-7, MS-LS2-3	**Academic Vocabulary:** aerobic cellular respiration, autotroph, biomass, calorie, carbohydrate, control, energy, food, heterotroph, kilocalorie, photosynthesis
Lesson Frame: Growing Producers	We will:
	I will:
Lesson Frame: Biomass and Producers	We will:
	I will:
Lesson Frame: Ecoscenario Producers	We will:
	I will:
Lesson Frame: Energy Transfer from Food	I will:
	We will:
Essential Questions: •What is the effect of light on producers? •What do producers need to grow and increase biomass? •What are the roles of specific producers in the ecosystem? •How can we model and measure energy transfer from food?	**Outcomes:** Students explore the effect of light on photosynthesis by studying wheat plants. Students learn that through photosynthesis, producers increase the biomass of an ecosystem. Students investigate the producers in specific ecosystems and identify their roles. Students model and measure the energy transferred from food.
Performance Tasks: •Grow plants to determine the role light energy plays in growth of producers in ecosystems. •Analyze experimental data to determine that plants require water, carbon dioxide, and light to produce biomass •Burn food to model and measure the energy transferred from food	**Learning Targets:** Students will Learn that: •photosynthesis is the process by which energy-rich molecules are made from water, carbon dioxide, and light. •photosynthesis produces potential energy and aerobic cellular respiration transfers usable energy to organisms. •producers increase the biomass of an ecosystem through photosynthesis; ecosystems are defined by their producers. •food is energy-rich organic matter that organisms need to conduct their life processes.

Topic 6: **Following the Energy**	**Length:** 7 sessions
Standard(s): MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-3	**Academic Vocabulary:** bioaccumulation, carnivore, herbivore, omnivore, sustainable, trophic level
Lesson Frame: Using Energy	We will:
	I will:
Lesson Frame: Food-Chain Game	We will:
	I will:
Lesson Frame: Trophic Levels	I will:
	We will:
Lesson Frame: Decomposers	I will:
	We will:
Essential Questions: •What are the kinds of work you do that require energy? •What is needed to sustain a food chain? •How does biomass and energy flow through an ecosystem? •What happens to the energy stored in the biomass of an organism when it does?	**Outcomes:** Students learn how energy provided by producers is used by all organisms. They explore how food energy moves from one trophic level to another through feeding relationships. Students simulate feeding relationships and determine what is needed to sustain a food chain. They investigate the role of decomposers in ecosystems.
Performance Tasks: •Construct an explanation for how organisms get the energy they need for life •Develop and use a model to explain how matter and energy transfer across trophic levels in an ecosystem.	**Learning Targets:** Students will learn that: •every activity undertaken by living organisms involves expenditure of energy. •feeding relationships identify trophic roles. •biomass moves through an ecosystem from one trophic level to the next; only a small fraction of the biomass consumed at a level is used to produce growth (biomass) at that level; most of the biomass consumed is used for energy and much is lost to the environment. •decomposers recycle food molecules to basic particles for use by organisms in the ecosystem.
Topic 7: **Population Size**	**Length:** 8 sessions
Standard(s): MS-LS2-1, MS-LS2-2, MS-LS2-4	**Academic Vocabulary:** interdependent, limiting factor, migrate, reproductive potential
Lesson Frame: Reproductive Potential	We will:
	I will:
Lesson Frame: Limiting Factors	We will:
	I will:
Lesson Frame: Population Dynamic	I will:
	We will:
Essential Questions: •How many milkweed bugs could be in your habitat at the end of a year? •What are the limiting factors that affect algae and brine shrimp populations at Mono Lake? •How does predicted population growth compared to actual population growth?	**Outcomes:** Students explore some of the variables in an ecosystem that limit population size. Based on their milkweed-bug study, they predict what the population would be in 12 months. Students use simulations to explore population interactions and outcomes.

Performance Tasks: •Calculate the theoretical growth of a population of milkweed bugs, assuming there are no limiting factors •Use computer simulations to model how reproductive strategies and limiting factors affect population growth •Analyze field observations to determine the effects of biotic factors on population size •Describe the population fluctuations in Mono Lake in terms of limiting factors and feeding relationships and support conclusions with evidence	**Learning Targets:** Students will learn that: •reproductive potential is the theoretical unlimited growth of a population over time. •a limiting factor is any biotic or abiotic component of the ecosystem that controls the size of a population.
Topic 8: **Human Impact**	**Length:** 7 sessions
Standard(s): MS-LS2-4, MS-ESS3-3, MS-ESS3-4	**Academic Vocabulary:** biodiversity, biodiversity index, introduced species, invasive species, native species, sampling, unbiased
Lesson Frame: Biodiversity	We will:
	I will:
Lesson Frame: Invasive Species	We will:
	I will:
Lesson Frame: Mono Lake Revisited	We will:
	I will:
Essential Questions: •Why is biodiversity important in an ecosystem? •What can happen when a species is introduced to an ecosystem? •What impact have people had on Mono Lake?	**Outcomes:** Students explore the importance of biodiversity on the health of the ecosystem. They investigate how humans have interacted with the ecosystem and put stresses on biodiversity. Students then learn how humans can reverse these stresses and help restore ecosystems.
Performance Tasks: •Conduct a field survey of the biodiversity of an ecosystem •Calculate the biodiversity index for a sample of the schoolyard •Explore the impact of humans on an ecosystem	**Learning Targets:** Students will learn that: •biodiversity is the variety of organisms in an ecosystem. •a biodiversity index is one measure of the health of an ecosystem, and its ability to recover from stress. In a sustainable ecosystem, the system is resilient to change. •introduced species compete with native species in an ecosystem. •if an introduced species has no predators in the new ecosystem, it can thrive and become invasive. •humans affect ecosystems in both positive and negative ways.
Topic 9: **Ecoscenarios**	**Length:** 7 sessions
Standard(s): MS-LS2-4, MS-LS2-5, MS-ESS3-3, MS-ESS3-4, MS-ETS1-1, MS-ETS1-2	**Academic Vocabulary:** cultural service, provisioning service, regulating service, supporting service
Lesson Frame: Human Involvement	We will:
	I will:
Lesson Frame: Evaluating Solutions	We will:
	I will:
Lesson Frame: Presentations	We will:

	I will:
Essential Questions: •How have humans affected your ecoscenario, and what efforts have humans made to lessen this impact?	**Outcomes:** Students return to their ecoscenarios and use the knowledge developed in previous investigations to analyze the effects of human interactions in their ecosystem. They are given several engineering solutions and evaluate which they feel is the best solution to preserve or restore the ecosystem.
Performance Tasks: •Discuss ways that human activities affect natural ecosystems •Evaluate possible solutions for preserving and restoring natural ecosystems using evidence to support a case •Recommend natural solutions to balance the sustainability of an ecosystem with human needs for ecosystem services	**Learning Targets:** Students will learn that: •humans rely on ecosystems for ecosystem services (provisioning, regulating, cultural, and supporting services). •ecosystems are dynamic systems of complex interactions. •disruptions to abiotic factors in ecosystems can cause shifts in populations and changes to ecosystem sustainability. •changes in ecosystems can affect services essential to humans. •solutions can be engineered to mitigate human impact.

Unit Name: **Waves**	**Length:** approximately 35
Standards: MS-PS4-1, MS-PS4-2, MS-PS4-3, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4	**Outcomes:** Students measure their pulse under different circumstances to think about frequency. They create waves using metal springs. They use these simple waves to explore the fundamental properties of waves: wavelength, frequency, and amplitude. Students learn about wave energy and compare energy in waves with different properties. Students look at an engineering failure and consider the work engineers must do to achieve a successful design. They use these ideas to develop a chamber that can effectively block sound waves. Students explore properties of light waves. They start by using mirrors to explore reflection. Students use spectroscopes to analyze spectra of visible light and learn more about the electromagnetic spectrum. They use filters to change the spectrum of a light source and to learn about color. Finally, they determine how refraction changes the path of light rays as they travel between media. Students learn how information can be encoded and sent as digital waves to transfer large amounts of information efficiently over large distances. They test properties of fiber optic cables to develop an understanding of how total internal reflection allows data transfer by light. Students learn how data is encoded and sent as modulated waves to a recipient for demodulation. Students create digital waves and develop an understanding of how digital waves enable modern communications.

Essential Questions: What is frequency? What defines a wave? What is the relationship between waves properties and wave energy? How are engineering challenges solved? What is the best way to insulate a recording studio from outside sounds? What happens when light waves interact with matter? What do spectra reveal about light? What makes objects appear as different colors? What happens to light waves at the interface between different media? What are some design constraints in fiber optic communication? How is sound sent through radio waves? How are images sent through radio waves?	**Learning Targets:** Students will learn that: •a wave is a back-and-forth pattern of motion that transfers energy. •key features of waves are crests, troughs, and nodes. •waves can be described in terms of wavelength, frequency, and amplitude. •if you know the frequency and wavelength, you can calculate the velocity of a wave. •a mechanical wave travels through a medium. •the amplitude, frequency, and wavelength of a wave are related to the energy transferred by the wave. •the frequency and wavelength of a wave are related. •planning, researching, modeling, and testing can help engineers develop successful designs. •a sound wave is a mechanical wave, so it requires a medium to travel. •waves interacting with media can be absorbed or reflected. •a wave model can be used to explain the properties of light. •light travels in straight lines, except at the interface between transparent media where refraction occurs. •the angle of incidence equals the angle of reflection. •the electromagnetic spectrum extends beyond visible light. •different wavelengths of visible light are perceived as different colors. •when light shines on an object, the light is reflected, absorbed, or transmitted through the object. •light can be transmitted long distances through optical fibers. •complex information like words, sounds, and images must be encoded to be sent as light. •digital waves can have the same information as analog waves; digital waves can be improved by smaller increments. •many modern communication devices use digitized signals (sent as waves) as a reliable way to encode and transmit information. •modern technology encodes information to improve transmission quality, reliability, and speed.
Topic 1: **Make Waves**	**Length:** 6 sessions
Standard(s): MS-PS4-1	**Academic Vocabulary:** amplitude, compression wave, crest, frequency, kinetic energy, longitudinal wave, node, pulse, reflection, transverse wave, trough, velocity, wave, wavelength
Lesson Frame: Pulse Rate	We will: explore compressions waves using springs
	I will: create a sheet of observations and drawings of compression waves
Lesson Frame: Spring Waves	We will: demonstrate wave pulses and frequency using our pulse as an example
	I will: complete an exit ticket explaining how our pulse is an example of wave frequency

Essential Questions: •What is frequency? •What defines a wave?	**Outcomes:** Students measure their pulse under different circumstances to think about frequency. They create waves using metal springs. They use these simple waves to explore the fundamental properties of waves: wavelength, frequency, and amplitude.
Performance Tasks: •Collect frequency data from multiple sources •Create and describe longitudinal and transverse waves •Apply computational thinking when diagramming a wave, measuring its properties, and calculating velocity	**Learning Targets:** Students will learn that: •a wave is a back-and-forth pattern of motion that transfers energy. •key features of waves are crests, troughs, and nodes. •waves can be described in terms of wavelength, frequency, and amplitude. •if you know the frequency and wavelength, you can calculate the velocity of a wave.

Topic 2: **Wave Energy**	**Length:** 10 sessions
Standard(s): MS-PS4-1, MS-PS4-2, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4	**Academic Vocabulary:** absorb, brainstorm, constraint, criterion, decibel, energy, inverse relationship, mechanical wave, medium, prototype, research, variable
Lesson Frame: Energy in Waves	We will: examine the energy in waves looking at ocean waves as an example
	I will: complete a sheet analyzing aspects of a mechanical wave
Lesson Frame: Bridge Collapse	We will: test waves to measure the energy present in the wave
	I will: analyze and discuss as groups the finding from the activity focusing on energy in the waves
Lesson Frame: Energy in Sound Waves	We will: watch videos and discuss engineering disasters and asses solutions to avoid further disasters
	I will: analyze how we used the engineering process to address the engineering disasters
Essential Questions: •What is the relationship between waves properties and wave energy? •How are engineering challenges solved? •What is the best way to insulate a recording studio from outside sounds?	**Outcomes:** Students learn about wave energy and compare energy in waves with different properties. Students look at an engineering failure and consider the work engineers must do to achieve a successful design. They use these ideas to develop a chamber that can effectively block sound waves.
Performance Tasks: •Modify a model to see what happens when a property of a wave is changed •Evaluate information about a historical engineering failure •Design a sound studio that meets specified criteria and constraints	**Learning Targets:** Students will learn that: •a mechanical wave travels through a medium. •the amplitude, frequency, and wavelength of a wave are related to the energy transferred by the wave. •the frequency and wavelength of a wave are related. •planning, researching, modeling, and testing can help engineers develop successful designs. •a sound wave is a mechanical wave, so it requires a medium to travel. •waves interacting with media can be absorbed or reflected.

Topic 3: **Light Waves**	**Length:** 10 sessions
Standard(s): MS-PS4-3	**Academic Vocabulary:** angle of incidence, angle of reflection, color, electromagnetic spectrum, electromagnetic wave, filter, incident beam, interface, laser, normal line, ray, reflected beam, refraction, spectroscope, spectrum, total internal reflection
Lesson Frame: Mirrors	We will: use mirrors and lasers in an activity that introduces light wave properties
	I will: complete a challenge using knowledge gained on light waves and then comparing lasers and light bulbs
Lesson Frame: Spectra	We will: discuss reflection and angles of reflections from the activity and reading
	I will: gather data from activity then answer the questions on the activity found on your sheet
Lesson Frame:Color	we will: learn about the electromagnetic spectrum by looking at light through various colored filters
	I will:
Lesson Frame: Refraction	We will:
	I will:
Essential Questions: •What happens when light waves interact with matter? •What do spectra reveal about light? •What makes objects appear as different colors? •What happens to light waves at the interface between different media?	**Outcomes:** Students explore properties of light waves. They start by using mirrors to explore reflection. Students use spectroscopes to analyze spectra of visible light and learn more about the electromagnetic spectrum. They use filters to change the spectrum of a light source and to learn about color. Finally, they determine how refraction changes the path of light rays as they travel between media.
Performance Tasks: •Use lasers to carry out investigations of optical properties of different media •Use light spectra to identify light sources, and collect evidence to support light-wave explanations about color	**Learning Targets:** Students will learn that: •a wave model can be used to explain the properties of light. •light travels in straight lines, except at the interface between transparent media where refraction occurs. •the angle of incidence equals the angle of reflection. •the electromagnetic spectrum extends beyond visible light. •different wavelengths of visible light are perceived as different colors. •when light shines on an object, the light is reflected, absorbed, or transmitted through the object.
Topic 4: **Communication Waves**	**Length:** 9 sessions
Standard(s): MS-PS4-3	**Academic Vocabulary:** amplitude modulation (AM), analog, binary, carrier wave, demodulation, digital, fiber optics, frequency modulation (FM), modulation, optical fiber, pixel, resolution

Lesson Frame: Optical Fibers	We will:	
	I will:	
Lesson Frame: Sending Sound	We will:	
	I will:	
Lesson Frame: Sending Images	We will:	
	I will:	
Essential Questions: •What are some design constraints in fiber optic communication? •How is sound sent through radio waves? •How are images sent through radio waves?	**Outcomes:** Students learn how information can be encoded and sent as digital waves to transfer large amounts of information efficiently over large distances. They test properties of fiber optic cables to develop an understanding of how total internal reflection allows data transfer by light. Students learn how data is encoded and sent as modulated waves to a recipient for demodulation. Students create digital waves and develop an understanding of how digital waves enable modern communications.	
Performance Tasks: •Transmit data through optical fibers to test design constraints •Analyze graphical displays of carrier waves, sound waves, and modulated waves to understand their relationships and describe their properties.	**Learning Targets:** Students will learn that: •light can be transmitted long distances through optical fibers. •complex information like words, sounds, and images must be encoded to be sent as light. •digital waves can have the same information as analog waves; digital waves can be improved by smaller increments. •many modern communication devices use digitized signals (sent as waves) as a reliable way to encode and transmit information. •modern technology encodes information to improve transmission quality, reliability, and speed.	

Unit Name: Gravity and Kinetic Energy	**Length:** approximately 38
Standards: MS-PS2-1, MS-PS2-2, MS-PS2-4, MS-PS2-5, MS-PS3-1, MS-PS3-2, MS-PS3-5, MS-ESS1-2, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4	**Outcomes:** Students see an unprotected “bean brain” fall to the floor and start to think about speed, acceleration, energy transfer, and collisions. They walk along two interval tracks to collect data about speed. After graphing their results, they conclude that the slope of a graph of distance versus time is related to the speed. They then walk along a different interval track and discover that the speed required is not constant. They graph their results to learn about acceleration. Finally, students observe a ball dropping and complete a detailed analysis of its motion. They determine that the ball is not falling at a constant speed, but accelerating. They calculate the rate and compare it to the acceleration of gravity, to develop a working definition of gravity. Students use spring scales to learn about the difference between mass and weight. They compare mass and weight on different planets, then refine their definition of gravity. Students learn about Newton’s second law of motion, which describes the relationship between mass, force, and acceleration. Students roll marbles down a ramp system to collide with plastic cubes. They gather data about the cubes’ motion to make inferences about kinetic and potential energy. Students do an activity in which they review data from different collision scenarios. They analyze the data in two ways to draw conclusions about the effect of mass and speed on collisions. Finally, students experiment with horizontal collisions, learn more about Newton’s laws, and consider the implications in various situations. Students view a video that introduces the physics concept of impulse. They learn that increasing the time it takes for an object to change speed in a collision results in less force being applied to the object. Using this principle, students design a protective helmet for a model head. After several iterative designs, they share results as a class and discuss the engineering design process. To finish the course, students review big ideas and create a list of remaining physics questions. Students work together to answer questions and prepare for the Posttest.

Essential Questions: What is speed? What is acceleration? What is gravity? What is the relationship between mass and weight? What is gravity like on other planets compared to Earth? How is potential energy related to kinetic energy? How does the kinetic energy of an object change when its speed or mass changes? How do Newton's laws help us explain marble billiards? Which properties of physics can help us design protection from a collision? What are the big ideas that explain gravity, accelerations, kinetic energy, and collisions?	**Learning Targets:** Students will learn that: •the average speed of an object is the distance it travels in a unit of time. •the slope of the line on a graph of distance versus time represents the speed; steeper slopes represent faster speeds. •an object that does not move at a constant speed has acceleration, change of speed per unit time. •a falling object increases speed with a constant acceleration, regardless of the object's mass. •gravity is an attractive force between two objects with a rate of acceleration of 9.8 m/s2 on Earth. • gravity is an attractive force between two objects. • mass is the amount of matter in an object. •weight is the force of gravity on an object. •the acceleration of an object increases if the force acting upon it increases (F = ma). • if identical force is applied to two objects with different masses, the more massive object will accelerate less than the less massive object (F = ma). •kinetic energy is energy of moving things; potential energy is energy dependent on the position of an object. •a collision transfers kinetic energy. •increasing the mass of an object by some factor increases its kinetic energy by the same factor; increasing the speed of an object by some factor increase its kinetic energy by the same factor squared. •an object in motion will stay in motion with the same speed unless acted on by an external force. •for every action, there is an equal and opposite reaction. •impulse is force applied over a period of time. •extending the time of a collision, by slowing an object's deceleration, results in less force on the object. •safety feature to protect humans in collisions use properties of physics to slow deceleration. •engineers use an iterative process to solve problems.
Topic 1: **Acceleration**	**Length:** 13 sessions
Standard(s): MS-PS2-2, MS- PS2-4	**Academic Vocabulary:** acceleration, air resistance, average speed, constant speed, distance, force, gravity, position, slope, speed
Lesson Frame: Speed Track	We will: analyze the data found on speed and graph our findings
	I will: compare the data found in my experiment with classmates and share results on a ticket to leave
Lesson Frame: Acceleration Track	We will: use our knowledge from learning about speed and learn how the speed equation applies to acceleration
	I will: use the speed equation and apply it to answer the questions on the half sheet about acceleration
Lesson Frame: Acceleration of Gravity	We will: walk tracks at different speeds with set distances to learn about acceleration
	I will: enter data from lab on my report and calculate acceleration
Essential Questions: • What is speed? • What is acceleration? • What is gravity?	**Outcomes:** Students see an unprotected “bean brain” fall to the floor and start to think about speed, acceleration, energy transfer, and collisions. They walk along two interval tracks to collect data about speed. After graphing their results, they conclude that the slope of a graph of distance versus time is related to the speed. They then walk along a different interval track and discover that the speed required is not constant. They graph their results to learn about acceleration. Finally, students observe a ball dropping and complete a detailed analysis of its motion. They determine that the ball is not falling at a constant speed, but accelerating. They calculate the rate and compare it to the acceleration of gravity, to develop a working definition of gravity.

Performance Tasks: •Analyze line slope to make claims about an object's speed •Construct and analyze data sets to identify patterns and distinguish between speed and acceleration •Use digital tools to analyze motion video data and determine the force of gravity on Earth	**Learning Targets:** Students will learn that: •the average speed of an object is the distance it travels in a unit of time. •the slope of the line on a graph of distance versus time represents the speed; steeper slopes represent faster speeds. •an object that does not move at a constant speed has acceleration, change of speed per unit time. •a falling object increases speed with a constant acceleration, regardless of the object's mass. •gravity is an attractive force between two objects with a rate of acceleration of 9.8 m/s2 on Earth.
Topic 2: **Force of Gravity**	**Length:** 8 sessions
Standard(s): MS-PS2-2, MS-PS2-4, MS-PS2-5, MS-ESS1-2	**Academic Vocabulary:** gram, mass, Newton, weight
Lesson Frame:Mass and Weight	We will: analyze a ball drop video to assess acceleration due to gravity
	I will: complete a sheet to demonstrate my knowledge of acceleration
Lesson Frame: How Heavy?	We will: perform an activity highlighting why objects are heavy and then read about the Law of Gravity
	I will: complete the questions from the reading with my partner demonstrating my understanding of the law of gravity
Essential Questions: •What is the relationship between mass and weight? •What is gravity like on other planets compared to Earth?	**Outcomes:** Students use spring scales to learn about the difference between mass and weight. They compare mass and weight on different planets, then refine their definition of gravity. Students learn about Newton’s second law of motion, which describes the relationship between mass, force, and acceleration.
Performance Tasks: • Calculate weight at locations with different gravitational forces •Analyze data to construct explanations about proportional relationships between mass, force, and acceleration	**Learning Targets:** Students will learn that: • gravity is an attractive force between two objects. • mass is the amount of matter in an object. •weight is the force of gravity on an object. •the acceleration of an object increases if the force acting upon it increases (F = ma). • if identical force is applied to two objects with different masses, the more massive object will accelerate less than the less massive object (F = ma).
Topic 3: **Energy and Collisions**	**Length:** 10 sessions
Standard(s): MS-PS2-1, MS-PS2-2, MS-PS3-1, MS-PS3-2, MS-PS3-5	**Academic Vocabulary:** collision, energy, friction, joule, kinetic energy, potential energy, variable
Lesson Frame: Potential and Kinetic Energy	We will: observe collisions to learn about the connections between potential and kinetic energy
	I will: complete and exit ticket explaining the transfer of energy in collisions from potential to kinetic
Lesson Frame: Stop or Crash	We will: design and perform and experiment with a ramp and a marble to measure the energy transferred
	I will: write an explanation detailing why the marble's speed at the bottom of the ramp was the greatest
Lesson Frame: Marble Collisions	We will: conduct a stop or crash activity to assess the change of an object's kinetic energy
	I will: analyze the data from the activity to quantify the energy change

Essential Questions: •How is potential energy related to kinetic energy? •How does the kinetic energy of an object change when its speed or mass changes? •How do Newton's laws help us explain marble billiards?	**Outcomes:** Students roll marbles down a ramp system to collide with plastic cubes. They gather data about the cubes' motion to make inferences about kinetic and potential energy. Students do an activity in which they review data from different collision scenarios. They analyze the data in two ways to draw conclusions about the effect of mass and speed on collisions. Finally, students experiment with horizontal collisions, learn more about Newton's laws, and consider the implications in various situations.
Performance Tasks: •Collect and analyze data from collisions to determine the relationships between speed, mass, and kinetic energy	**Learning Targets:** Students will learn that: •kinetic energy is energy of moving things; potential energy is energy dependent on the position of an object. •a collision transfers kinetic energy. •increasing the mass of an object by some factor increases its kinetic energy by the same factor; increasing the speed of an object by some factor increase its kinetic energy by the same factor squared. •an object in motion will stay in motion with the same speed unless acted on by an external force. •for every action, there is an equal and opposite reaction.
Topic 4: **Engineering**	**Length**: 7 sessions
Standard(s): MS-PS2-1, MS-S3-5, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4	**Academic Vocabulary:** constraint, criterion, impulse
Lesson Frame: Helmet Design Challenge	We will: use or knowledge about physics to design a helmet to protect a "bean brain"
	I will: analyze and compare successful designs as a group using our physics terms to explain success or failure
Lesson Frame: Big Ideas	We will: discuss the results of the activity and what this means to people and the importance of helmets and how they protect against concussions
	I will: answer questions from the article on concussions to solidify our learning to real world problems
Essential Questions: •Which properties of physics can help us design protection from a collision? •What are the big ideas that explain gravity, accelerations, kinetic energy, and collisions?	**Outcomes:** Students view a video that introduces the physics concept of impulse. They learn that increasing the time it takes for an object to change speed in a collision results in less force being applied to the object. Using this principle, students design a protective helmet for a model head. After several iterative designs, they share results as a class and discuss the engineering design process. To finish the course, students review big ideas and create a list of remaining physics questions. Students work together to answer questions and prepare for the Posttest.
Performance Tasks: •Define an engineering problem and design solutions through an iterative process •Engage in argument from evidence to evaluate solutions to a design challenge •Develop and use a model to describe the iterative process of engineering design •Construct explanations and ask questions about physics concepts related to kinetic energy, gravity, and collisions	**Learning Targets:** Students will learn that: •impulse is force applied over a period of time. •extending the time of a collision, by slowing an object's deceleration, results in less force on the object. •safety feature to protect humans in collisions use properties of physics to slow deceleration. •engineers use an iterative process to solve problems.

Unit Name: **Earth History**	**Length:** approximately 64
Standards: MS-ESS1-4, MS-ESS2-1, MS-ESS2-2, MS-ESS2-3, MS-ESS3-1, MS-ESS3-2, MS-ESS3-3, MS-ESS3-4, MS-ESS3-5, MS-LS4-1	**Outcomes:** Earth Is Rock uses the anchor phenomenon of the Grand Canyon to introduce students to the study of the landforms and rocks that make up Earth's crust. Through observations of aerial images of Earth's surface, sedimentary rock samples, and images from the Grand Canyon, students begin developing awareness about the complexity of Earth's crust and how geologists study it by trying to answer the question "What is the story of this place?" In Weathering and Erosion students explore the phenomena of earth material movement over the surface of Earth. Students observe a stream table to discover how water can erode sediments from one location and deposit the sorted sediments in a basin downstream. They model how rocks weather and what happens to sediments. Students also consider how soil forms. In Deposition, students investigate the phenomenon of the variety of sedimentary rocks on Earth. They look closely at the processes by which bedrock that is weathered and eroded ends up deposited in basins. There, favorable conditions can turn the sediments into sedimentary rock. Students consider how evidence in sedimentary rocks can lead to inferences about the ancient environments in which they formed. In Fossils and Past Environments, students experience the phenomenon of fossils. Students become familiar with the geologic time scale to understand how old fossils are and begin to comprehend the enormous spans of time that are described by geologic time. They use fossils to put the history of the Grand Canyon into the geologic time scale. Igneous Rocks presents students with new rock samples from a new location. It leads to an investigation of the relationship between crystal size and the formation of igneous rocks. The formation of igneous rocks is the phenomenon investigated by students. Volcanoes and Earthquakes provides engaging phenomena to investigate and gives students the opportunity to discover a pattern of geologic activity. Subduction, convection, and the theory of crustal plate tectonics are introduced to explain continental drift, plate boundary interactions, and the patterns of volcanoes and earthquakes. Mountains and Metamorphic Rocks builds on the phenomena of earthquakes and volcanoes by focusing on new landforms— mountains. Students investigate the interactions at plate boundaries that form mountains and metamorphic rocks, leading students to consider the rock cycle. In Geo Scenarios, students apply prior knowledge from the Earth History Course and new, site-specific information to develop a geologic story of a place or process. Students are introduced to four sites across the United States— four phenomena. Each team of students researches the story of one of those places, the processes that shaped it, and the implications of the story for human society. What Is Earth's Story? challenges students to put together what they have learned about Earth's geologic history and to use their knowledge to finish telling the story of the phenomenal Grand Canyon.

Essential Questions:	**Learning Targets:**
Which landforms occur at different locations on Earth? Why do there appear to be stripes on the walls of the Grand Canyon? Why do there appear to be stripes on the walls of the Grand Canyon? What happens to earth materials when water flows over landforms? How did weathering and erosion contribute to the formation of the Grand Canyon? How is soil related to rocks? What happens to sediments that get deposited in basins? How does limestone form? What do sedimentary rock layers reveal about ancient environments? How do fossils get in rocks? How old are fossils? When did the Grand Canyon rocks form? How do igneous rocks form? What affects crystal formation in igneous rocks? What can crystal size tell us about where an igneous rock formed? Where do volcanoes occur on Earth and where do earthquakes occur on Earth? Why do volcanoes and earthquakes occur where they do? What causes plates to move? What happens to Earth's crust during plate interactions? How do metamorphic rocks form? What do we need to know to tell the geologic story of a place? What is the geologic story of the Grand Canyon? How do earth materials recycle through constructive and destructive processes?	Students will learn that: •Earth's surface has a variety of different landforms and water features. •every place on Earth's surface has a unique geologic story. •rocks hold the clues to the story of a place. •limestone, sandstone, and shale are rocks found in the Grand Canyon that can be identified by their characteristics. •most landforms are shaped by slow, persistent processes that proceed over the course of millions of year: weathering, erosion, and deposition. •rock can be weathered into sediments by a number of processes, including frost wedging, abrasion, chemical dissolution, and root wedging. •particles of earth material can be categorized and sorted by size: clay, silt, sand, gravel, pebble, cobble, and boulder. •most sediments move downhill until they are deposited in a basin. Sediments that do not form rock can become widely distributed over Earth's surface as soil. •sediments deposited by water usually form flat, horizontal layers. •sediments turn into solid rock (such as sandstone, shale, and limestone) through the process of lithification, which involves compaction, cementation, and dissolution. •the relative ages of sedimentary rock can be determined by the sequence of layers. Lower layers are older than higher layers. •the processes we observe today, such as weathering, erosion, and deposition, probably acted in the same way millions of year ago, producing sedimentary rocks. •a fossil is any remains, trace, or imprint of a plant or animal that was preserved in Earth's crust during ancient times. •the fossil record represents what we know about ancient life and is constantly refined as new fossil evidence is discovered. •geologic time extends from Earth's origin to the present. •Earth's history is measured in millions and billions of years. •Index fossils allow rock layers to be correlated by age over vast distances. •Earth is composed of layers of earth materials, from its hard crust of rock all the way down to its hot core. •heat inside Earth melts rock; melted rock can cool and form igneous rocks. •molten rock cools quickly on the surface of Earth and can be identified by small mineral crystals. Molten rock that cools more slowly inside Earth forms larger mineral crystals. •volcanoes and earthquakes occur along plate boundaries. •Earth's crust and solid upper mantle make up Earth's plates. Plates can be the size of continents or larger or smaller. •Earth's plates "float" on top of the layer of viscous, semi solid earth material below-- the asthenosphere. •The asthenosphere is a heated, semisolid, semifluid material that flows due to convection currents. •Plate movements result in plate-boundary interactions that produce volcanoes, earthquakes, and continental drift. •interactions between tectonic plates at their boundaries deform the plates, producing landforms on Earth's surface. •mountains form as a results of plate interactions. •when plates interact, high heat and immense pressure can change rock into new forms of rock (metamorphic rock). •the rock cycle describes how rock is constantly being recycled and how each type of rock can be transformed into other rock types.

Topic 1:**Earth is a Rock**	**Length:** 8 sessions
Standard(s): MS-ESS1-4, MS-ESS2-1, MS-ESS2-2	**Academic Vocabulary:** calcite, correlation, elevation, geologist, landform, layer, limestone, sandstone, shale
Lesson Frame: What's the Story of This Place?	We will:
	I will:
Lesson Frame: Grand Canyon Rocks	We will:
	I will:
Lesson Frame: Correlating Grand Canyon Rocks	We will:
	I will:
Essential Questions: •Which landforms occur at different locations on Earth? •Why do there appear to be stripes on the walls of the Grand Canyon?	**Outcomes:** Earth Is Rock uses the anchor phenomenon of the Grand Canyon to introduce students to the study of the landforms and rocks that make up Earth’s crust. Through observations of aerial images of Earth’s surface, sedimentary rock samples, and images from the Grand Canyon, students begin developing awareness about the complexity of Earth’s crust and how geologists study it by trying to answer the question “What is the story of this place?”
Performance Tasks: •Make and record observations of landforms on Earth's surface and some of the rocks that compose them •Analyze rock samples from different sites to construct rock correlation	**Learning Targets:** Students will learn that: •Earth's surface has a variety of different landforms and water features. •every place on Earth's surface has a unique geologic story. •rocks hold the clues to the story of a place. •limestone, sandstone, and shale are rocks found in the Grand Canyon that can be identified by their characteristics.
Topic 2: **Weather and Erosion**	**Length:** 9 sessions
Standard(s): MS-ESS2-1, MS-ESS2-2	**Academic Vocabulary:** abrasion, basin, bedrock, chemical reaction, chemical weathering, clay, deposition, differential erosion, erosion, frost wedging, humus, mineral, model, physical weathering, rock, rock fall, root wedging, sand, sediment, silt, soil, soil profile, sorting, weathering
Lesson Frame: Stream Table	We will:
	I will:
Lesson Frame: Weathering	We will:
	I will:
Lesson Frame: Soils	We will:
	I will:

Essential Questions: •What happens to earth materials when water flows over landforms? •How did weathering and erosion contribute to the formation of the Grand Canyon? •How is soil related to rocks?	**Outcomes:** In Weathering and Erosion students explore the phenomena of earth material movement over the surface of Earth. Students observe a stream table to discover how water can erode sediments from one location and deposit the sorted sediments in a basin downstream. They model how rocks weather and what happens to sediments. Students also consider how soil forms.
Performance Tasks: •Sort earth materials by size, using water •Use models to represent, study, and manipulate Earth processes	**Learning Targets:** Students will learn that: •most landforms are shaped by slow, persistent processes that proceed over the course of millions of year: weathering, erosion, and deposition. •rock can be weathered into sediments by a number of processes, including frost wedging, abrasion, chemical dissolution, and root wedging. •particles of earth material can be categorized and sorted by size: clay, silt, sand, gravel, pebble, cobble, and boulder. •most sediments move downhill until they are deposited in a basin. Sediments that do not form rock can become widely distributed over Earth's surface as soil.
Topic 3: **Deposition**	**Length:** 6 sessions
Standard(s): MS-ESS1-4, MS-ESS2-1, MS-ESS2-2	**Academic Vocabulary:** cement, cementation, compaction, groundwater, horizontal, ooze, precipitate, principle of original horizontality, principle of superposition, sedimentary rock, uniformitarianism
Lesson Frame: Sandstone and Shale	We will:
	I will:
Lesson Frame: Limestone	We will:
	I will:
Lesson Frame: Interpreting Sedimentary Layers	We will:
	I will:
Essential Questions: •What happens to sediments that get deposited in basins? •How does limestone form? •What do sedimentary rock layers reveal about ancient environments?	**Outcomes:** In Deposition, students investigate the phenomenon of the variety of sedimentary rocks on Earth. They look closely at the processes by which bedrock that is weathered and eroded ends up deposited in basins. There, favorable conditions can turn the sediments into sedimentary rock. Students consider how evidence in sedimentary rocks can lead to inferences about the ancient environments in which they formed.

Performance Tasks: •Identify components of sandstone, shale, and limestone •Infer change in environments through the interpretation of a sequence of sedimentary rock layers	**Learning Targets:** Students will learn that: •sediments deposited by water usually form flat, horizontal layers. •sediments turn into solid rock (such as sandstone, shale, and limestone) through the process of lithification, which involves compaction, cementation, and dissolution. •the relative ages of sedimentary rock can be determined by the sequence of layers. Lower layers are older than higher layers. •the processes we observe today, such as weathering, erosion, and deposition, probably acted in the same way millions of year ago, producing sedimentary rocks.
Topic 4: **Fossils and Past Environments**	**Length:** 10 sessions
Standard(s): MS-ESS1-4, MS-LS4-1	**Academic Vocabulary:** Cenozoic, crossbreeding, cross section, epoch, era, formation, fossil, fossil record, geologic time, index fossil, law of fossil succession, mesozoic, paleontology, paleozoic, period, Precambrian, relative time scale, stratigraphy, unconformity
Lesson Frame: Fossils	We will:
	I will:
Lesson Frame: A Long Time Ago	We will:
	I will:
Lesson Frame: Index Fossils	We will:
	I will:
Essential Questions: •How do fossils get in rocks? •How old are fossils? •When did the Grand Canyon rocks form?	**Outcomes:** In Fossils and Past Environments, students experience the phenomenon of fossils. Students become familiar with the geologic time scale to understand how old fossils are and begin to comprehend the enormous spans of time that are described by geologic time. They use fossils to put the history of the Grand Canyon into the geologic time scale.
Performance Tasks: •Construct a timeline of geologic events and ancient life •Infer ancient environments, based on rock and fossil evidence •Describe how rocks can be given a relative age, based on their relationship to other rocks	**Learning Targets:** Students will learn that: •a fossil is any remains, trace, or imprint of a plant or animal that was preserved in Earth's crust during ancient times. •the fossil record represents what we know about ancient life and is constantly refined as new fossil evidence is discovered. •geologic time extends from Earth's origin to the present. •Earth's history is measured in millions and billions of years. •Index fossils allow rock layers to be correlated by age over vast distances.
Topic 5: **Igneous Rocks**	**Length:** 6 sessions

Standard(s): MS-ESS2-1, MS-ESS2-2	**Academic Vocabulary:** asthenosphere, crust, crystal, crystallize, extrusive, igneous rock, inner core, intrusive, lava, lithosphere, magma, mantle, outer core
Lesson Frame: Earth's Layers	We will:
	I will:
Lesson Frame: Salol Crystals	We will:
	I will:
Lesson Frame: Types of Igneous Rocks	We will:
	I will:
Essential Questions: •How do igneous rocks form? •What affects crystal formation in igneous rocks? •What can crystal size tell us about where an igneous rock formed?	**Outcomes:** Igneous Rocks presents students with new rock samples from a new location. It leads to an investigation of the relationship between crystal size and the formation of igneous rocks. The formation of igneous rocks is the phenomenon investigated by students.
Performance Tasks: •Identify properties of a new set of rock samples, differentiating them from sedimentary rocks •Design an experiment to test how cooling rate affects crystal size •Confirm a relationship between cooling rate and crystal size that can be applied to igneous rock formation	**Learning Targets:** Students will learn that: •Earth is composed of layers of earth materials, from its hard crust of rock all the way down to its hot core. •heat inside Earth melts rock; melted rock can cool and form igneous rocks. •molten rock cools quickly on the surface of Earth and can be identified by small mineral crystals. Molten rock that cools more slowly inside Earth forms larger mineral crystals.
Topic 6: **Volcanoes and Earthquakes**	**Length:** 7 sessions
Standard(s): MS-ESS2-2, MS-ESS2-3, MS-ESS3-1, MS-ESS3-2	**Academic Vocabulary:** active, continental drift, continental shelf, convection, convergent boundary, divergent boundary, dormant, earthquake, extinct, latitude, longitude, plate, plate boundary, ring of fire, seismology, spreading ridge, subduction zone, tectonic, theory of plate tectonics, transform, boundary, volcano, volcanology
Lesson Frame: Mapping Volcanoes and Earthquakes	We will:
	I will:
Lesson Frame: Moving Continents	We will:
	I will:
Lesson Frame: Plate Tectonics	We will:
	I will:

Essential Questions: •Where do volcanoes occur on Earth and where do earthquakes occur on Earth? •Why do volcanoes and earthquakes occur where they do? •What causes plates to move?	**Outcomes:** Volcanoes and Earthquakes provides engaging phenomena to investigate and gives students the opportunity to discover a pattern of geologic activity. Subduction, convection, and the theory of crustal plate tectonics are introduced to explain continental drift, plate boundary interactions, and the patterns of volcanoes and earthquakes.
Performance Tasks: •Analyze volcano and earthquake data for patterns •Model continental drift that has occurred on Earth •Describe how convection and plate tectonics drive continental drift •model plate-=boundary interactions	**Learning Targets:** Students will learn that: •volcanoes and earthquakes occur along plate boundaries. •Earth's crust and solid upper mantle make up Earth's plates. Plates can be the size of continents or larger or smaller. •Earth's plates "float" on top of the layer of viscous, semi solid earth material below-- the asthenosphere. •The asthenosphere is a heated, semisolid, semifluid material that flows due to convection currents. •Plate movements result in plate-boundary interactions that produce volcanoes, earthquakes, and continental drift.
Topic 7: **Mountains and Metamorphic Rocks**	**Length:** 9 sessions
Standard(s): MS-ESS2-1, MS-ESS2-2, MS-ESS2-3	**Academic Vocabulary:** dome, fault, fault block, fold, foliation, gneiss, marble, metamorphic rock, plateau, quartzite, rock cycle, schist, slate, subduction, trench, uplift
Lesson Frame: Plate Models	We will:
	I will:
Lesson Frame: Metamorphic Rocks	We will:
	I will:
Essential Questions: •What happens to Earth's crust during plate interactions? •How do metamorphic rocks form?	**Outcomes:** Mountains and Metamorphic Rocks builds on the phenomena of earthquakes and volcanoes by focusing on new landforms— mountains. Students investigate the interactions at plate boundaries that form mountains and metamorphic rocks, leading students to consider the rock cycle.
Performance Tasks: •Simulate plate interactions to produce various landforms •Model the metamorphic rock process •Apply understanding of geologic processes (plate tectonics and the rock cycle) to interpret rock evidence	**Learning Targets:** Students will learn that: •interactions between tectonic plates at their boundaries deform the plates, producing landforms on Earth's surface. •mountains form as a results of plate interactions. •when plates interact, high heat and immense pressure can change rock into new forms of rock (metamorphic rock). •the rock cycle describes how rock is constantly being recycled and how each type of rock can be transformed into other rock types.
Topic 8: **Geoscenarios**	**Length:** 5 sessions

Standard(s): MS-ESS3-1, MS-ESS3-2, MS-ESS3-3, MS-ESS3-4, MS-ESS3-5	**Academic Vocabulary:** (none)
Lesson Frame: Introduction to the Project	We will:
	I will:
Lesson Frame: Research and Writing	We will:
	I will:
Lesson Frame: Presentations	We will:
	I will:
Essential Questions: •What do we need to know to tell the geologic story of a place?	**Outcomes:** In Geoscenarios, students apply prior knowledge from the Earth History Course and new, site-specific information to develop a geologic story of a place or process. Students are introduced to four sites across the United States— four phenomena. Each team of students researches the story of one of those places, the processes that shaped it, and the implications of the story for human society.
Performance Tasks: •Interpret various data resources to learn about a geologic site or process •Collaborate as a team to bring together data and develop an evidence-based story of a place or process •Describe how human activities and values interact with geologic processes in societal decision making •Present and communicate findings to the rest of the class	**Learning Targets:** Students will learn that: •geologic processes help tell the story of a physical place. •evidence and observations of a site's geology provide clues to tell the geologic story. •knowledge of uplift, plate tectonics, volcanism, weathering, erosion, and fossil evidence plus the principles of uniformitarianism, superposition, and original horizontality can help tell the story of a place.
Topic 9: **What is Earth's Story?**	**Length:** 4 sessions
Standard(s): MS-ESS1-4, MS-ESS2-1, MS-ESS2-2, MS-ESS2-3	**Academic Vocabulary:** (none)
Lesson Frame: Revisit the Grand Canyon	We will:
	I will:
Lesson Frame: Review the Evidence	We will:
	I will:
Essential Questions: •What is the geologic story of the Grand Canyon? •How do earth materials recycle through constructive and destructive processes?	**Outcomes**: What Is Earth's Story? challenges students to put together what they have learned about Earth's geologic history and to use their knowledge to finish telling the story of the phenomenal Grand Canyon.

Performance Tasks:	Learning Targets:
•Analyze evidence from rocks, landforms, and other resources to put together Earth's geologic story	Students will learn that: •evidence that provides clues about Earth's geologic history comes from observing rocks, landforms, and other earth materials. •scientists specialize in many different disciplines to collect and analyze evidence to help put together Earth's geologic history. •scientists use a number of different tools and techniques to analyze and synthesize evidence obtained from Earth to tell its story.