Louisiana Sample Scope and Sequence for Science Instruction

This scope and sequence document was developed to assist teachers with the implementation of the Louisiana Student Standards for Science. This tool is not full curriculum and will need to be further built out by science educators. It has been designed to help in the initial transition to the new standards.

This document is considered a "living" document, as we believe that teachers and other educators will find ways to improve it as they use it. Please send feedback to LouisianaStandards@la.gov so that we may use your input when updating this tool.

About the Sample Scope and Sequence Tools

The Louisiana Student Standards for Science represent the knowledge and skills needed for students to successfully transition to postsecondary education and the workplace. The standards call for students to:

- Apply content knowledge
- Investigate, evaluate, and reason scientifically
- Connect ideas across disciplines

This scope and sequence document is designed to assist teachers, schools, and districts with the development of instructional resources that align with the Louisiana Student Standards for Science. This scope and sequence is only a sample; it does not illustrate the only appropriate sequence to teach the standards or the only possible ways to bundle the standards. The bundles can be reorganized around different phenomenon, including phenomenon specific to Louisiana or to a region in Louisiana.

Based on the instructional shifts, this tool uses phenomena to drive 3-dimensional science instruction. The incorporated phenomena are observable events that occur in the universe and can be explained by science. They establish the purpose for learning and help students to connect their learning to real-world events.

- The standards are bundled into units.
- The units are built around an anchor phenomenon.
- One unit has been built out further to contain a series of investigative phenomena, which have been sequentially organized to reinforce one another and build toward the performance expectations.

Throughout each unit, students should have multiple opportunities to apply the science and engineering practices, make sense of the crosscutting concepts, and develop a deep understanding of disciplinary core ideas.

Building out the Science Scope and Sequences for Classroom Instruction

How to Use the Anchor and Investigative Phenomena[1]

1. Explore the anchor phenomenon
2. Attempt to make sense of the phenomenon
3. Identify related phenomena
4. Develop questions and next steps
5. Explore investigative phenomena to help make sense of the anchor phenomenon
6. Communicate scientific reasoning around the anchor phenomenon

Instructional Process

Choosing an Anchor Phenomenon

Students should be able to make sense of anchoring phenomenon, but not immediately, and not without investigating it using sequences of the science and engineering practices. With instruction and guidance, students should be able to figure out, step by step, how and why the phenomenon works. [2]

A good anchor phenomenon[3]:

- ☐ is too complex for students to explain or design a solution for after a single lesson.
  - The explanation is just beyond the reach of what students can figure out without instruction.
  - Searching online will not yield a quick answer for students to copy.
- ☐ can be a case (pine beetle infestation, building a solution to a problem), something that is puzzling (why isn't rainwater salty?), or a wonderment (how did the solar system form?).
- ☐ has relevant data, images, and text to engage students in the range of ideas students need to understand. It should allow them to use a broad sequence of science and engineering practices to learn science through first-hand or second-hand investigations.
- ☐ will require students to develop an understanding of and apply multiple performance expectations while also engaging in related acts of mathematics, reading, writing, and

[1] adapted from How do we bring 3-dimensional learning into our classroom?

[2] Using Phenomenon

[3] Qualities of a Good Anchor Phenomenon

communication.

- ☐ is observable to students. "Observable" can be with the aid of scientific procedures (e.g., in the lab) or technological devices to see things at very large and very small scales (telescopes, microscopes), video presentations, demonstrations, or surface patterns in data.

Choosing Investigative Phenomena

Students should be able to make sense of investigative phenomenon, but not immediately, and not without investigating it using sequences of the science and engineering practices. With instruction and guidance, students should be able to figure out, step-by-step, how and why the phenomenon works.[4]

A good investigative phenomenon:

- ☐ helps students make sense of one or two parts of the anchor phenomenon.
- ☐ has relevant data, images, and text to engage students in the range of ideas students need to understand.
- ☐ can be understood or explained by students using the science and engineering practices.

Investigating the Phenomena

When a phenomenon is introduced, whether anchor or investigative, students should have the opportunity to make observations, discuss current understandings, and pose questions about the phenomenon. Once questions are compiled, it may be helpful to categorize questions as follows:

- Questions that can be investigated by our class
- Questions that can be investigated but not with our current resources and equipment
- Questions that can be researched
- Questions that cannot be answered (due to current technologies or scientific limitations)

Other Useful Questions When Designing a Sequence of Learning[5]

- How do we kick off investigations in a unit?
- How do we work with students to motivate the next step in an investigation?
- How do we help students use practices to figure out the pieces of the science ideas?
- How do we push students to go deeper and revise the science ideas we have built together so far?
- How do we help students put together pieces of the disciplinary core ideas and crosscutting concepts?

[4] Using Phenomenon

[5] Questions to Guide the Development of a Classroom Culture That Supports "Figuring Out"

Fourth Grade Science Standards Overview

The Fourth Grade Science course focuses on the study of energy, waves and their applications in technologies for information transfer, from molecules to organism: structures and processes, Earth's place in the universe, Earth's system, Earth and human activity.

	Science and Engineering Practices									
Crosscutting Concepts		Asking Questions and Defining Problems	Developing and Using Models	Planning and Carrying Out Investigations	Analyzing and Interpreting Data	Using Mathematics and Computational Thinking	Constructing Explanations and Designing Solutions	Engaging in Argument from Evidence	Obtaining, Evaluating, and Communicating Information	All Domains
	Patterns		4-PS4-1		4-ESS2-2		4-ESS1-1			
	Cause and Effect	4-ESS2-3	4-PS4-2	4-ESS2-1			4-LS1-2 4-ESS3-2		4-ESS3-1	
	Scale, Proportion and Quantity									
	Systems and System Models							4-LS1-1		
	Energy and Matter	4-PS3-3		4-PS3-2			4-PS3-1 4-PS3-4			
	Structure and Function									
	Stability and Change									

Overview of Sample Units

	Unit 1 Weathering and Erosion	Unit 2 Earth's Processes	Unit 3 Structures and Processes of Organisms	Unit 4 Waves and Communications	Unit 5 Energy	Unit 6 Earth and Human Activity
Anchor Phenomenon	Louisiana loses about 75 square kilometers of coastline annually. **Multidisciplinary Opportunity:** Louisiana Guidebook Hurricanes Unit	Fossils of dire wolves, saber tooth cats, and wooly mammoths are among the over 3.5 million fossils found in Los Angeles, California.	Bald eagles are capable of seeing fish in the water from several hundred feet above, while soaring and circling in the air. However, fishermen have a difficult time seeing fish just beneath the surface of water.	Bat carcasses are found in caves with missing brains.	Arizona has a crater that is over one mile across and more than 550 feet deep.	Developing countries now have more cell phone users than the world's richer countries.
Standards	4-ESS2-1 4-ESS2-3 4-ESS2-2* 4-ESS3-2 4-PS4-1*	4-ESS1-1 4-ESS2-2*	4-PS4-2 4-LS1-1 4-LS1-2	4-PS4-1* 4-LS1-1 4-LS1-2	4-PS3-1 4-PS3-3	4-PS3-2 4-PS3-4 4-ESS3-1

* The performance expectation is only partially addressed using the identified phenomenon. The performance expectation is addressed in other unit(s).

Unit 1: Weathering and Erosion

About the Standards

Performance Expectations

- 4-ESS2-1 Earth's System: Plan and conduct investigations on the effects of water, ice, wind, and vegetation on the relative rate of weathering and erosion.
- 4-ESS2-2* Earth's System: Analyze and interpret data from maps to describe the patterns of Earth's features.
- 4-ESS2-3 Earth's System: Ask questions that can be investigated and predict reasonable outcomes about how living things affect the physical characteristics of their environment.
- 4-ESS3-2 Earth and Human Activity: Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
- 4-PS4-1* Waves and their Applications in Technologies for Information Transfer: Develop a model of waves to describe patterns in terms of amplitude and wavelength and to show that waves can cause objects to move.

* The performance expectation is only partially addressed using the identified phenomenon. The performance expectation is addressed in other unit(s).

Disciplinary Core Ideas

DCI	Partial Unpacking of the DCI
Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (DCI: UE.ESS2A.a; PE: 4-ESS2-1)	• Living things depend upon the environment around them; rainfall impacts that environment • Erosion is the movement of rocks, soil, and sediment from one place to another • Water can break down rock and soil, increasing the rate of erosion • Ice erosion occurs when a large chunk of ice, usually a glacier, is moved (often due to gravity) and wears away the rocks or soil • Wind, or the movement of air, also causes erosion • Living things impact the movement of rocks, soil, and sediments in different ways • Some natural substances erode faster than others
Living things affect the physical characteristics of their	• Living things are "biotic factors" in their environment

environment. (DCI: UE.ESS2E.a; PE: 4-ESS2-1, 4-ESS2-3)	• Plants affect the environment in many ways: they use carbon dioxide and produce oxygen, they die and decay and become part of the soil, some have roots that can stabilize or destabilize the soil • Animals affect the environment in many ways: some eat plants, they disturb rocks, soil, and sediment, some build dams or nests, others burrow into the ground • Some living things impact their environment more than others
A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (DCI: UE.ESS3B.a; PE: 4-ESS3-2)	• Natural weather events such as tornados, hurricanes, strong winds, and excessive rain can cause damage to natural and man-made structures. • Humans cannot control natural weather events but can take steps to prevent those events from causing as much damage. • Among other things, structures can be built outside of the natural floodplains; structures can be built to prevent areas from flooding (levees, barrier islands); and forecasting can prevent loss of life.
Testing a solution involves investigating how well it performs under a range of likely conditions. (DCI: UE.ETS1B.d; PE: 4-ESS3-2)	• Part of the engineering process is testing a solution. • Structures are impacted by the conditions around it. • Engineers test their solutions under many conditions to determine the strengths and weaknesses of the solution.
The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features of Earth. (DCI: UE.ESS2B.a; PE: 4-ESS2-2)	*While this unit incorporates maps and geographic data regarding land and water, it does not focus on mountain ranges, deep ocean trenches, and most other geographical landforms mentioned in this DCI. • Maps can be used to track and illustrate changes of land and water features over time.
Waves, which are regular patterns of motion, can be made in water by disturbing	• Water waves are the movement of water up and down. • Waves occur in regular patterns. • Waves vary in amplitude (height) and wavelength.

the surface. When waves move across the surface of deep water, the water goes up and down in place; it does not move in the direction of the wave except when the water meets the beach. (DCI: UE.PS4A.a; PE: 4-PS4-1)	• Waves move up and down in deep water, not in a horizontal direction. • When waves meet the beach, they act differently by moving towards the shore.
Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (DCI: UE.PS4A.b; PE: 4-PS4-1))	*This unit only addresses waves in water. Other studies of wave should be integrated into other units. • Water waves vary in amplitude and wavelength

Science and Engineering Practices

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
- Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.
- Analyze and interpret data to make sense of phenomena using logical reasoning.
- Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.

Crosscutting Concepts

- Cause and effect relationships are routinely identified, tested, and used to explain change.
- Patterns can be used as evidence to support an explanation.
- Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products.

Putting the Standards into Practice

Explore the anchor phenomenon

Sample Anchor Phenomenon: Louisiana loses about 75 square kilometers of land annually.

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and share photos, quotes, and data that are appropriate with students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

USGS – Louisiana Coastal Wetlands: A Resource at Risk
Losing Ground
Louisiana's Coastline is Disappearing at the Rate of a Football Field an Hour
USGS Louisiana Land Loss Simulation
30 Years of Time Lapse Videos
A New Subsidence Map for Coastal Louisiana
Chandeleur Islands

Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- What is causing Louisiana land loss?
- How are nonliving things causing weathering and erosion of Louisiana's coastline?
- How do living things impact weathering and erosion of Louisiana's coastline?
- How do natural hazards such as hurricanes and flooding impact Louisiana's coastline?
- How can we use patterns in maps and waves to better understand natural hazards such as hurricanes?
- What are scientists and engineers doing to try to decrease the rate of the loss of the land?
- How has the rate of land loss changed over time?
- Are other regions in the United States or around the world also experiencing significant land loss?

Teachers should provide Investigative Phenomenon based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Investigative Phenomena

Sample 1: Different types of rocks and sediment react differently to wind and water.

Sample questions for students to investigate:

- How do different types of sediment "behave" similarly and differently when exposed to the same models of wind and water movement?
- Does the force of the wind impact how different materials "behave?"
- How does the amount or force of water impact different materials?
- Where does the sediment go when it moves due to wind and water?

3-D learning opportunities:

SEP: Ask questions; Plan and carry out investigations

DCI: UE.ESS2A.a

CC: Cause and effect

Sample 2: The Colorado River carved the Grand Canyon.

National Park Service: The Grand Canyon
Grand Canyon: Location, Formation, and Facts

Sample questions for students to investigate:

- How did gravity impact erosion of the Grand Canyon?
- What caused weathering of the Grand Canyon?
- Is the Grand Canyon continuing to erode?
- What do the formation of the Grand Canyon and the disappearance of the Louisiana coastline have in common? How are they different?

3-D learning opportunities:

SEP: Obtain, evaluate, and communicate information; Construct explanations

DCI: UE.ESS2A.a; UE.ESS2B.a

CC: Cause and effect

Sample 3: Nutria thrive in the Louisiana wetlands.

Beaver Sized Rodents are Devouring Louisiana
Louisiana's Love-Hate Relationship with Nutrias
National Geographic: Nutria

3-D learning opportunities:

Sample questions for students to investigate: • What environmental factors make the wetlands a good home for nutria? • How do nutria impact the Louisiana wetlands? • How are scientists and engineers trying to control the nutria? • What solution could be designed to better control the nutria population? • What other living things negatively impact the Louisiana wetlands?	SEP: Define problems; Design solutions; Construct explanations; Obtain, evaluate, and communicate information DCI: UE.ESS2E.a; UE.ETS1B.d CC: Cause and effect

Sample 4: Hurricane Katrina dramatically increased the rate of land loss in the year of 2005, when compared to other years.

Accessing the Impact of Hurricane Katrina in Louisiana
Land Area Changes in Coastal Louisiana After Hurricanes Katrina and Rita
Historical Hurricane Tracks

Sample questions for students to investigate: • Why was Hurricane Katrina so damaging to Louisiana's coast? • What caused Hurricane Katrina? • Have other hurricanes hit Louisiana that caused as much damage? • Have there been storms in other parts of the world that caused similar damage? • How did the levee system, which was engineered by humans, contribute and/or prevent damage? • Is there a pattern to the formation and path of hurricanes?	**3-D learning opportunities:** SEP: Obtain, evaluate, and communicate information; Analyze and interpret data DCI: UE.ESS2A.a; UE.ESS3B.a CC: Cause and effect; Patterns

Sample 5: Water waves cause objects to oscillate.

Sample questions for students to investigate: • How do waves impact objects that sink? How do they impact objects that float? • Do waves ever move objects in a forward or backward direction? • How do water waves cause damage to the Louisiana coastline or wetlands? • Does the amplitude of waves impact how they move objects? • What causes the amplitude of water waves to increase or decrease?	**3-D learning opportunities:** SEP: Construct explanations; Obtain evaluate, and communicate information; Plan and carry out investigations DCI: UE.PS4A.a; UE.PS4A.b; UE.ETS1B.d

• What solution could be engineered to decrease the impact of waves on buoyant objects?	CC: Patterns

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Describe the impact of living and nonliving things on Louisiana's coastline.
- Generate two different solutions to Louisiana's disappearing coastline and determine the strengths and weaknesses of both proposals.

Unit 2: Earth's Processes

About the Standards

Performance Expectations

- 4-ESS1-1 Earth's Place in the Universe: Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in landforms over time.
- 4-ESS2-2* Earth's System: Analyze and interpret data from maps to describe the patterns of Earth's features.

Science and Engineering Practices

- Identify the evidence that supports particular points in an explanation.
- Analyze and interpret data to make sense of phenomena using logical reasoning.

Crosscutting Concepts

- Patterns can be used as evidence to support an explanation.

Putting the Standards into Practice

Explore the anchor phenomenon

Sample Anchor Phenomenon: Fossils of dire wolves, saber tooth cats, and wooly mammoths are among the over 3.5 million fossils found in Los Angeles, California.

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and pull photos, quotes, and data that are appropriate to share with fourth grade students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

La Brea Tar Pits
Timeline: Animals of the La Brea Tar Pits
Excavating 101
CBS: Scientists Dig for Fossils at La Brea Tar Pits
National Geographic: The Tar Pit
Read Works: Learning from Dinosaur Fossils
Read Works: The Age of Dinosaurs
Read Works: Piecing Together the Story of Dinosaurs from Fossils

Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- What are the La Brea Tar Pits and where are the pits located?
- How do the tar pits help to preserve fossils?
- How did earthquakes along the San Andreas Fault contribute to the La Brea Tar Pits?
- What evidence can we gather from patterns in rock formations and fossils in rock layers at La Brea Tar Pits that reveal Earth's landscape has changed over time?

Teacher should provide Investigative Phenomenon based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Explain how the patterns in rock formations and fossils in rock layers from La Brea Tar pits to explain changes in land forms over time.
- Analyze and interpret data from maps to describe patterns in Earth's features along the San Andreas Fault line.

Unit 3: Structures and Processes of Organisms

About the Standards

Performance Expectations

- 4-PS4-2 Waves and Their Applications in Technologies for Information: Transfer Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
- 4-LS1-1 From Molecules to Organisms: Structure and Processes: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- 4-LS1-2 From Molecules to Organisms: Structure and Processes: Construct an explanation to describe how animals receive different types of information through their senses, process the information in their brains, and respond to the information in different ways.

Science and Engineering Practices

- Construct and/or support an argument with evidence, data, and/or a model.
- Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).
- Develop and/or use models to describe and/or predict phenomena.

Crosscutting Concepts

- A system can be described in terms of its components and their interactions.
- Events that occur together with regularity might or might not be a cause and effect relationship.
- Cause and effect relationships are routinely identified, tested, and used to explain change.

Putting the Standards into Practice

Explore the anchor phenomenon

Sample Anchor Phenomenon: Bald eagles can see fish in the water from several hundred feet above, while soaring and circling in the air. However, fishermen have a difficult time seeing fish just beneath the surface of water.

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and pull photos, quotes, and data that are appropriate to share with fourth grade students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

National Geographic: Eagle vs Snake
U.S. Fish & Wildlife Services: Eagles Across America
Bald Headed Eagle
Read Works: Back from the Brink
National Geographic: Bald Eagles
National Wildlife Federation: Bald Eagles
What if Humans had Eagle Vision?
All about Birds: Eagles

Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- How does the vision of an eagle differ from the vision of a human?
- How can understanding the internal and external structures of plants and animals assist scientists in explaining how organisms survive in their environment?
- How do eagles receive information through their senses and process information in their brains to respond to their environment?
- How does light energy assist in visual and other types of information transfer?

Teacher should provide Investigative Phenomenon based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Develop a model depicting how an eagle sees.
- Construct an argument that bald eagles have internal and external structures that function to support survival, growth, behavior, and reproduction.
- Explain how bald eagles process and respond to information.

Unit 4: Waves and Communication

About the Standards

Performance Expectations

- 4-PS4-1* Waves and their Applications in Technologies for Information Transfer: Develop a model of waves to describe patterns in terms of amplitude and wavelength and to show that waves can cause objects to move.
- 4-LS1-1 From Molecules to Organisms: Structure and Processes: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- 4-LS1-2 From Molecules to Organisms: Structure and Processes: Construct an explanation to describe how animals receive different types of information through their senses, process the information in their brains, and respond to the information in different ways.

Science and Engineering Practices

- Construct and/or support an argument with evidence, data, and/or a model.
- Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).
- Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.

Crosscutting Concepts

- A system can be described in terms of its components and their interactions.
- Events that occur together with regularity might or might not be a cause and effect relationship.
- Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products.

Putting the Standards into Practice

Explore the anchor phenomenon

Sample Anchor Phenomenon: Bat carcasses are found in caves with missing brains.

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and pull photos, quotes, and data that are appropriate to share with fourth grade students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

Great Tits (*Parus major*) Birds Eat Bats in Times of Need
Great Tits (*Parus major*) Hunt for Pipistrelle Bats
Smithsonian: Here's What Bat Echolocation Sounds Like, Slowed.
Read Works: All About Bats (Article Set)
Western Pipistrelle bat
Sound waves
Scientific American: How do Bats Echolocate and How Are They Adapted to This Activity?

Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- What happened to the bats and why are their brains missing?
- How do bats use sound waves to communicate?
- How did the Great Tits (*Parus major*) find the bats in the dark caves?
- How do scientists use sound wave patterns to analyze echolocation and communication between bats?
- How do the internal and external structures of Great Tits (*Parus major*) and bats support their survival, growth, behavior, and reproduction?
- How do bats and Great Tits (*Parus major*) receive sound information through their senses (ears), process the information in their brains, and respond to the information in different ways?

Teacher should provide Investigative Phenomenon based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Create a model to explain how bats communicate with one another. Explain how the Great Tits (*Parus major*) use bat communication to prey on them.
- Construct an argument with supporting evidence that animals and plants have internal and external structures that function to support survival, growth, behavior, and reproduction.
- Compare how Great Tits (*Parus major*) and bats receive and process information.

Unit 5: Energy

About the Standards

Performance Expectations

- 4-PS3-1 Energy Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- 4-PS3-3 Energy Ask questions and predict outcomes about the changes in energy that occur when objects collide.

Science and Engineering Practices

- Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
- Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

Crosscutting Concepts

- Energy can be transferred in various ways and between objects.

Putting the Standards into Practice

Explore the anchor phenomenon

Sample Anchor Phenomenon: Arizona has a crater that is over one mile across and more than 550 feet deep.

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and pull photos, quotes, and data that are appropriate to share with fourth grade students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

Meteor Crater (Barringer Crater), Arizona
Meteor Crater Arizona
Impact Craters on Earth
Weighing the Evidence

Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- How did the Barringer Crater form?
- How did scientists determine what formed the Barringer Crater?
- How fast was the meteorite traveling before it hit the ground?
- How did the speed of the meteorite impact the formation and size of the crater?
- How large was the meteorite?
- How does the speed of objects, specifically meteorites, contribute to amount of energy it possesses?
- What are balanced and unbalanced forces? How did forces contribute to the formation of the Barringer crater?
- How was energy transferred when the meteorite collided with the ground?

Teacher should provide Investigative Phenomenon based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Use evidence to construct an explanation about how the speed of the meteorite impacted the size of the Barringer Crater.
- Design an investigation to predict the outcome regarding the transfer of energy that occurs when a meteorite collides with Earth's surface.

Unit 6: Earth and Human Activity

About the Standards

Performance Expectations

- 4-PS3-2 Energy: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents
- 4-PS3-4 Energy: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- 4-ESS3-1 Earth and Human Activity: Obtain and combine information to describe that energy and fuels are derived from renewable and non-renewable resources and how their uses affect the environment

Science and Engineering Practices

- Obtain and combine information from books and/ or other reliable media to explain phenomena or solutions to a design problem.
- Apply scientific ideas to solve design problems.
- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

Crosscutting Concepts

- Cause and effect relationships are routinely identified, tested, and used to explain change.
- Energy can be transferred in various ways and between objects.

Putting the Standards into Practice

Explore the anchor phenomenon

Sample Anchor Phenomenon: Developing countries now have more cell phone users than the world's richer countries.

Resources: A number of resources for the anchor phenomenon are included below. Teachers should screen the resources and pull photos, quotes, and data that are appropriate to share with fourth grade students. These resources may not be appropriate to be given to students as they are due to the length, content, or accessibility of the content.

Lesson From the Cell Phone Phenomenon: How Microgrids Can Power Developing Countries
Department of Energy: How Microgrids Work
Berkeley Lab: About Microgrids
How do Solar Panels Work?
The New York Time: A Big Test for Big Batteries
Read Works: Energy of Life
Read Works: Energy Production

Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- How are developing countries different from the United States of America?
- How do people living in developing countries get energy to power their cell phones?
- What are "renewable powered microgrids"?
- Why do homes in India lose power when the sun goes down in the evening?
- How do solar panels capture energy from the sun to generate electricity in microgrids?
- How do India and other developing countries use energy from the sun to generate power in their homes?
- How is energy stored in microgrids?
- How is energy from the sun transformed into electrical energy?
- What alternative energy resources have engineers designed?
- What are the benefits of using renewable energy -solar, wind, water, nuclear?
- How do alternative energy resources, such as solar energy, help to reduce the use of fossil fuels?
- How are fossil fuels used by humans?
- What are the positive and negative effects of using fossil fuels?
- What is the difference between renewable and nonrenewable energy resources?

Teacher should provide Investigative Phenomenon based on student observations, questions, and the Characteristics of Quality Investigative Phenomenon.

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Describe how energy can be transferred from place to place by sound, light, heat, and electric currents.
- Design a device that converts energy from one form to another.
- Describe how renewable and non-renewable energy resources are different and their effect on the India's environment.