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 classroomsupporttoolbox@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 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

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

[2] Using Phenomena

[3] Qualities of a Good Anchor Phenomenon

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 Phenomena

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

Sixth Grade Science Standards Overview

The sixth grade science course focuses on the study of matter and its interactions, motion and stability: forces and interactions, energy, waves and their applications in technologies for information transfer, earth's place in the universe, earth and human activity, from molecules to organisms: structures and processes, ecosystems: interactions, energy, and dynamics.

	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		6-MS-ESS1-1			6-MS-PS4-1	6-MS-LS2-2			
	Cause and Effect	6-MS-PS2-3		6-MS-PS2-5	6-MS-LS2-1			6-MS-ESS3-4		
	Scale, Proportion and Quantity		6-MS-PS1-1	6-MS-LS1-1	6-MS-ESS1-3 6-MS-PS3-1					
	Systems and System Models		6-MS-ESS1-2 6-MS-PS3-2				6-MS-PS2-1	6-MS-PS2-4		
	Energy and Matter		6-MS-LS2-3							
	Structure and Function		6-MS-LS1-2 6-MS-PS4-2							
	Stability and Change			6-MS-PS2-2						

	Unit 1 Earth's Place in the Universe	Unit 2 Energy	Unit 3 Forces and Interactions	Unit 4 Electric, Magnetic, & Gravitational Forces	Unit 5 From Molecules to Organisms	Unit 6 Interdependent Relationships	Unit 7 Sound
Anchor Phenomenon	Earth is in the exact position in space to support life, including human life.	A relatively small catapult can bring down a castle.	Woodpeckers bang their heads against trees, yet they don't experience concussions. However, at least 60% of NFL football players have experienced at least one concussion after colliding with other players.	Cow and deer herds tend to point their bodies in a north-south line.	The Yellow Sea turns green in China.	The Great Barrier Reef is turning white.	We can sense many different sounds from a distance.
Standards	6-MS-ESS1-1 6-MS-ESS1-2 6-MS-ESS1-3	6-MS-PS2-2* 6-MS-PS3-1 6-MS-PS3-2	6-MS-PS2-1 6-MS-PS2-2 6-MS-PS3-1 6-MS-PS3-2*	6-MS-PS2-3 6-MS-PS2-4 6-MS-PS2-5	6-MS-PS1-1 6-MS-LS1-1 6-MS-LS1-2 6-MS-LS2-3	6-MS-LS2-1 6-MS-LS2-2 6-MS-ESS3-4	6-MS-PS4-1 6-MS-PS4-2

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

Unit 1: Earth's Place in the Universe

About the Standards

Performance Expectations

- 6-MS-ESS1-1: Earth's Place in the Universe: Develop and use a model of the Earth-sun-moon system to describe the reoccurring patterns of lunar phases, eclipses of the sun and moon, and seasons.
- 6-MS-ESS1-2: Earth's Place in the Universe: Use a model to describe the role of gravity in the motions within galaxies and the solar system.
- 6-MS-ESS1-3: Earth's Place in the Universe: Analyze and interpret data to determine scale properties of objects in the solar system.

Disciplinary Core Ideas

DCI	Partial Unpacking of the DCI
Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (DCI: MS.ESS1A.a; PE: 6-MS-ESS1-1)	• Earth rotates on its tilted axis once an Earth day • The moon rotates on its axis approximately once a month. • The moon orbits Earth approximately once a month. • The moon rotates on its axis at the same rate at which it orbits Earth so that the side of the moon that faces Earth remains the same as it orbits. • The moon's orbital plane is tilted with respect to the plane of the Earth's orbit around the sun • Earth-moon system orbits the sun once an Earth year • The Earth's rotation axis is tilted with respect to its orbital plane around the sun. Earth maintains the same relative orientation in space, with its North Pole pointed toward the North Star throughout its orbit. • Models can be used to explain the relationship and motion of the sun, the moon, and the stars.
This model of the solar system can explain eclipses of the Sun and the Moon. Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the Sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight	• Solar energy travels in a straight line from the sun and hits different parts of the curved Earth at different angles — more directly at the equator and less directly at the poles. • In the shadow of the moon that falls on Earth during a total solar eclipse, sunlight is prevented from reaching that part of Earth because the moon is located between the sun and Earth. • Some parts (wavelengths) of solar energy pass through Earth's atmosphere during a total lunar eclipse and strike

on different areas of Earth across the year. (DCI: MS. ESS1B.b PE: 6-MS-ESS1-1)	the moon because Earth is located between the sun and moon. • Earth is located between the sun and moon. • The Earth's rotation axis is tilted with respect to its orbital plane around the sun. Earth maintains the same relative orientation in space, with its North Pole pointed toward the North Star throughout its orbit. • Because the Earth's axis is tilted, the most direct and intense solar energy occurs over the summer months, and the least direct and intense solar energy occurs over the winter months. • The change in season at a given place on Earth is directly related to the orientation of the tilted Earth and the position of Earth in its orbit around the sun because of the change in the directness and intensity of the solar energy at that place over the course of the year. • Summer occurs in the Northern Hemisphere at times in the Earth's orbit when the northern axis of Earth is tilted toward the sun. Summer occurs in the Southern Hemisphere at times in the Earth's orbit when the southern axis of Earth is tilted toward the sun. • Winter occurs in the Northern Hemisphere at times in the Earth's orbit when the northern axis of Earth is tilted away from the sun. Winter occurs in the Southern Hemisphere at times in the Earth's orbit when the southern axis of Earth is tilted away from the sun.
Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (DCI: MS.ESS1A.b; PE: 6-MS-ESS1-2)	• The Milky Way galaxy is a collection of stars and their associated systems of objects. • There are many other galaxies in the universe, each containing many other stars.
The solar system consists of the sun and a collection of objects, including planets, their natural satellite(s) (moons), and asteroids that are held in orbit around the sun by its gravitational pull on them. (DCI: MS.ESS1B.a; PE: 6-MS-ESS1-2, 6-MS-ESS1-3)	• The solar system is a collection of bodies, including the sun, planets, moons, and asteroids. • Gravitational forces from planets cause smaller objects (e.g., moons) to orbit around planets. • The gravitational force of the sun causes the planets and other bodies to orbit around it, holding the solar system together. • The gravitational forces from the center of the Milky Way cause stars and stellar systems to orbit around the center of the galaxy.

The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (DCI: MS.ESSS1B.c; PE: 6-MS-ESS1-2)	• The solar system was established as the disk of dust and gas was driven by gravitational forces to form moon-planet and planet-sun orbiting systems.

Science and Engineering Practices

- Develop and/or use a model to predict and/or describe phenomena.
- Analyze and interpret data to determine similarities and differences in findings.

Crosscutting Concepts

- Patterns can be used to identify cause and effect relationships.
- Models (physical, mathematical, computer models) can be used to represent systems and their interactions- such as inputs, processes and outputs-and energy, matter, and information flows within systems.
- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Putting the Standards into Practice

Sample Anchor Phenomenon: Earth is in the exact position in space to support life, including human life.

Explore the anchor phenomenon

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 sixth 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.

What Makes Earth So Perfect for Life?
Why is Earth Habitable?

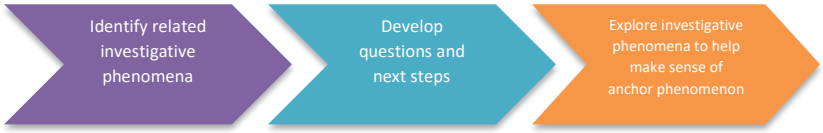
Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- What is the range of distance from the sun in which life on Earth could exist?
- Why isn't gravity pulling the Earth closer and closer to the sun?
- What patterns on Earth make it hospitable to life?
- How does the moon influence life on Earth?
- Is Earth the only planet has life?

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

Sample Investigative Phenomena



Sample 1: On August 21, 2017, a total solar eclipse occurred in North America.

NASA Eclipse 2017
NASA Eclipses Models
NASA: Looks to Solar Eclipse to Help Understand Earth's Energy System Article
NASA Eclipse Tracker
NSTA 3D Resources on Eclipse
NSF American Astronomical Society Educational Materials and Videos

Sample questions for students to investigate:

- What causes an eclipse?
- Why do some places see a total eclipse while others see a partial eclipse?
- Why do only certain areas of the planet see an eclipse?
- How can scientists predict the path in which an eclipse will be visible to people on Earth?
- Develop a model that illustrates the cause of a solar eclipse; adhere to the appropriate scale measurements.
- How does the position of the Earth, sun, and moon shape the ability of Earth to sustain life?

3-D learning opportunities:

SEP: Develop and use a model; Analyze and interpret data

DCI: MS.ESS1A.b; MS.ESS1B.a; MS.ESS1B.c

CC: Scale, proportion and quantity; Systems and Models; Patterns

Sample 2: Halley's Comet orbits the sun but has a slightly unpredictable pattern.

Chaotic Orbit of Comet Halley Explained
NASA: Comet Halley
Halley's Comet Returns in Bits and Pieces

Sample questions for students to investigate:	3-D learning opportunities:
• How can scientists predict the orbiting pattern of Halley's Comet? • What makes Halley difficult to predict with precision? • How does gravity impact other celestial bodies in the solar system? • How did the formation of the Milky Way Galaxy determine the patterns that occur today? • How does the orbital path of Halley's Comet and Earth compare? • How does the orbital path of Earth shape the ability of Earth to sustain life?	SEP: Obtain, evaluate, and communicate information; Construct explanations DCI: MS.ESS1B.a CC: Pattern; Systems and system models

Sample 3: According to NASA, "Our moon makes Earth a more livable planet by moderating our home planet's wobble on its axis, leading to a relatively stable climate, and creating a tidal rhythm that has guided humans for thousands of years. "

Sample questions for students to investigate:	3-D learning opportunities:
• Develop a model that illustrates how the moon impacts the "wobble" of Earth. • How does the moon impact Earth's climate? • What are tides and how does the moon cause them? What impact do the tides have on living and nonliving things? • How does the rotation and revolution of the moon both allow and limit the ability of people to study the moon without the aid of technology (with the naked eye)? • Why doesn't a lunar and solar eclipse occur every lunar cycle?	SEP: Develop and use a model; Obtain, evaluate and communicate information; Construct explanations DCI: MS.ESS1A.a; MS.ESS1B.b CC: Patterns; Systems

Sample 4: The Northern and Southern hemispheres on Earth experience opposite seasons.

Seasons and Tides
NOAA: Climate Data Online

Sample questions for students to investigate:	3-D learning opportunities:
• What causes Earth's seasonal cycles? • When comparing the data from two areas that are equidistant from the equator, are the climates the exact opposite? • How do the seasonal cycles of Earth shape the ability of Earth to sustain life?	SEP: Develop and use a model; Analyze and interpret data DCI: MS.ESS1B.b CC: Patterns

Sample 5: The length of daylight hours differs in different locations and in one location on different dates of the year.

NOAA: Sunrise/Sunset Calculator
Sunrise and Sunset Data

Sample questions for students to investigate:	3-D learning opportunities:
• How does the number of minutes of daylight change for a given date at different longitudes? Latitudes? • How does the number of minutes of daylight change for a given location (city or town) for different dates of the year? • What causes the differences in the length of daylight? • How does the changing amount of daylight time influence or shape life on Earth?	SEP: Use mathematical reasoning; Analyze and interpret data; Construct explanations DCI: MS.ESS1A.a CC: Patterns

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Develop a model of the Earth-Sun-Moon. Address the accuracy of size and distance (scale), including scale limitations.
- How does gravity impact the motions within galaxies and our solar system?
- How can data be used to determine scale properties of objects in the solar system?
- How does the position of Earth in space and the pattern of Earth's movement in space allow it to support the diversity of life that exists?

Unit 2: Energy

About the Standards

Performance Expectations

- 6-PS2-2* Motion and Stability: Forces and Interactions: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- 6-PS3-1 Energy: Construct and interpret graphical displays of data to describe the relationship of kinetic energy to the mass of an object and to the speed of an object.
- 6-PS3-2 Energy: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

* 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
The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (DCI: MS.PS2A.b; PE: 6-MS-PS2-2*)	• An object subject to balanced forces does not change its motion. It will continue in a straight line at the same speed. • An object subject to unbalanced forces changes its motion over time. It will speed up, slow down, and/or change direction. • The mass of an object impacts the amount of force needed to change its motion. • Larger forces impact objects more than smaller forces.
Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (DCI:	• Kinetic energy is the energy an object possesses due to its motion. • Kinetic energy is determined by the mass and speed of an object. For example, if mass is doubled, KE is doubled; if velocity is doubled, KE is quadrupled.

MS.PS3A.a; PE: 6-PS3-1)	• Kinetic energy doubles as the mass of an object doubles. For example, if mass is doubled, KE is doubled; if velocity is doubled, KE is quadrupled.
An object or system of objects may also contain stored (potential) energy, depending on their relative positions. (DCI: MS.PS3A.b; PE: 6-PS3-2)	• Potential energy is the energy an object contains by virtue of the object's position relative to other objects. • When the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (DCI: MS.PS3C.a; PE: 6-PS3-2)	• The transfer of energy can happen when two objects interact.

Science and Engineering Practices

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. Ask questions based on observations to find more information about the natural and/or designed world(s).
- Develop a model to describe unobservable mechanisms.
- Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.

Crosscutting Concepts

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including atomic scales. Events have causes that generate observable patterns.
- Models can be used to represent systems and their interactions- such as inputs, processes and outputs- and energy, matter, and information follows within systems.
- Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.

Putting the Standards into Practice

Sample Anchor Phenomenon A relatively small catapult can bring down a castle.

Explore the anchor phenomenon

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 sixth 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.

Catapult History
Energy Transfer: Engineering Catapults
Drone Collisions: Catapult Tests the Dangers of Drones
Stone Age Hunters Really Did Hunt Well by Throwing Stones

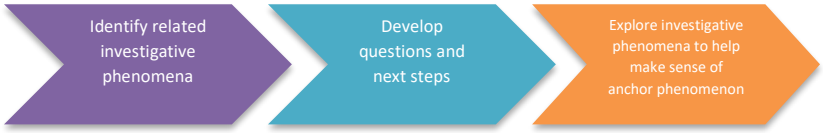
Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- How does the design of a catapult impact its ability to launch a projectile?
- How does the mass of the projectile contribute to the distance that it travels?
- What role does the orientation of a catapult's elastic or twisted rope play in its ability to launch an object?
- How does the energy from the elastic or twisted rope transfer to the projectile?
- How can air particles exert enough force to launch a projectile?
- How does energy transfer throughout a piston catapult's system?

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

Sample Investigative Phenomena



Sample 1: The game of tug-of-war being played.

Phet Forces and Motion Basics

Sample questions for students to investigate:

- During tug-of-war, how does the mass of the people impact the net force of the rope?
- How does the sum of the forces acting on the rope determine the movement and direction of the rope?
- When the net forces are balanced and unbalanced, how is the motion of the rope impacted?
- Develop a model that shows the impact of unbalanced forces on a rope.
- What does the game of tug-of-war and the launching of a projectile with a torsion catapult have in common? How are they different?

3-D learning opportunities:

SEP: Plan and carry out an investigation

DCI: MS.PS2A.b

CC: Stability and Change

Sample 2: The height variations of diving boards affect divers.

Synchronized Diving
How to Execute the Perfect Dive

Sample questions for students to investigate:

- How does the height of a diving board effect the potential energy of the diver?
- How does the mass of a diver impact the potential energy of the diver?
- What is the relationship between the height of an object and the object's kinetic energy?
- Develop a model illustrating how the height of a diving board and/or the mass of a person impact the energy of a diver.
- How is diving connected to the science of a catapult?
- If two diving boards are the same height but made of different materials, how will this impact the energy of the diver?

3-D learning opportunities:

SEP: Develop and use a model

DCI: MS.PS3A.a; MS.PSA.b; MS.PS3C.a

CC: Systems and system models

Sample 3: Bowling balls of the same mass roll down a bowling lane.

Sample questions for students to investigate:

- Will the balls always roll at the same speed?
- What impacts the speed of a bowling ball rolling down a lane?
- What makes balls roll differently?
- How does the mass of a bowling ball impact its kinetic energy?
- How does the speed of a bowling ball impact its kinetic energy?
- Design an investigation to collect data to explain how the mass of a ball impacts its kinetic energy.
- How does the relationship between the mass, speed, and force of a bowling ball connect to the launching of a catapult?

3-D learning opportunities:

SEP: Analyze and interpret data

DCI: MS.PS3A.a

CC: Scale, proportion and quantity

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- How does the design of a catapult impact its ability to launch a projectile?
- How does a catapult transfer potential energy to kinetic energy to launch a projectile?
- What is the relationship between kinetic energy and potential energy?
- What factors will affect the amount of potential and kinetic energy within a closed system?
- How is a projectile's kinetic energy related to the mass of the object that it's launching?
- Design a catapult that launch the furthest and with the greatest accuracy.

Unit 3: Forces and Interactions

About the Standards

Performance Expectations

- 6-MS-PS2-1 Motion and Stability: Forces and Interactions Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
- 6-MS-PS2-2 Motion and Stability: Forces and Interactions Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- 6-MS-PS3-1 Energy Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- 6-MS-PS3-2* Energy Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

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

Science and Engineering Practices

- Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.
- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.
- Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.
- Develop a model to describe unobservable mechanisms

Crosscutting Concepts

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.
- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including atomic scales.
- Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.
- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.

Putting the Standards into Practice

Sample Anchor Phenomenon: Woodpeckers bang their heads against trees, yet they do not experience concussions. However, at least 60% of NFL football players have experienced at least one concussion after colliding with other players.

Explore the anchor phenomenon

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 sixth 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.

How do Woodpeckers Absorb Shock?
Football and Concussions
What Happens to a Football Player's Brain During a Concussion?

Science of Football Players
Football: Mass, Momentum, and Collisions
NFL: Engineering Roadmap: Driving Progress Toward Better Protective Equipment

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

Try to make sense of the anchor phenomenon

- Why are football players experiencing a high rate of concussions?
- How do woodpeckers absorb shock and overcome brain damage?
- How are forces and motions used in football? Does this contribute to concussions?
- How do NFL organizations use science to prepare for football games and design solutions to overcome the high rate of concussions?
- How does the mass of football player impact the force of the collision?
- How does the speed of a football player impact the force of the collision?
- How does a football player set himself in motion?
- How have engineers designed football equipment to reduce game-related concussions?
- How does the net force applied to a football player affect his motion?
- How does the mass of a football player impact his net force on another player?

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

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Develop and use a model to describe the relationship of kinetic energy to the mass and the speed of football players.
- Describe how the change in a football player's motion depends on the mass and the sum of the forces acting on the player.
- Apply Newton's Third Law to design a solution to overcome the problem of concussions in football games.

Unit 4: Electric, Magnetic, and Gravitational Forces

About the Standards

Performance Expectations

- 6-MS-PS2-3 Motion and Stability: Forces and Interactions Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
- 6-MS-PS2-4 Motion and Stability: Forces and Interactions Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
- 6-MS-PS2-5 Motion and Stability: Forces and Interactions Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Science and Engineering Practices

- Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.
- Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.
- Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.

Crosscutting Concepts

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.

Putting the Standards into Practice

Sample Anchor Phenomenon: Cow and deer herds tend to point their bodies in a north-south line.

Explore the anchor phenomenon

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 sixth 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.

Power Lines Disrupt the Magnetic Alignment of Cows and Deer
Google Earth Shows that Cows and Deer Herds Align Like Compass Needles
Moo North
PNAS Study: Magnetic Alignment in Grazing and Resting Cattle and Deer

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

Try to make sense of the anchor phenomenon

- Why do cow and deer herds point in a north-south direction?
- How did scientists recognize this phenomenon? What evidence do scientists have to prove this phenomenon is occurring in the real world?
- Why is the orientation of deer and cow herds different when power lines are present?
- How do magnitude, the distance between objects, and the orientation of objects affect magnetic and electric forces?
- How and why do power lines disrupt the magnetic alignment of cows and deer?
- What effect do magnetic and electrical fields have on cow and deer herds?
- How are magnetic and electric forces impacting cow and deer herds if they are not in direct contact with one another?
- How are electric and magnetic forces different from one another?
- Have other factors such as wind and water impacted the orientation of the herds?
- How are magnetic and electrical fields created?
- Why are cow and deer herds referred to as “a living compass needle”?

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

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Make and support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
- Plan and conduct an experiment to provide evidence that fields exist between cow and deer herds and that they exert forces on the herds even though they are not in contact with them.
- What factors affect the strength of electric and magnetic forces acting on cow and deer herds?

Unit 5: From Molecules to Organisms

About the Standards

Performance Expectations

- 6-MS-PS1-1 Matter and Its Interactions Develop models to describe the atomic composition of simple molecules and extended structures.
- 6-MS-LS1-1 From Molecules to Organisms: Structures and Processes: Conduct an investigation to provide evidence that living things are made of cells, either one or many different numbers and types.
- 6-MS-LS1-2 From Molecules to Organisms: Structures and Processes: Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
- 6-MS-LS2-3* Ecosystems: Interactions, Energy and Dynamics: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

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

Science and Engineering Practices

- Develop and/or use a model to predict and/or describe phenomena.
- Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.
- Develop and/or use a model to predict and/or describe phenomena.

Crosscutting Concepts

- Phenomena that can be observed at one scale may not be observable at another scale.
- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends of the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.
- The transfer of energy can be traced as energy flows through a designed or natural system.
- Time, space, and energy phenomena can be observed at various scales using models to study systems that are large too large or too small.

Putting the Standards into Practice

Sample Anchor Phenomenon: The Yellow Sea turns green in China.

Explore the anchor phenomenon

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 sixth 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.

ABC News Article
New York Daily News Photos
NOAA: Algal Blooms
NOAA: Phytoplankton Blooms: The Basics
Marine Plankton Food Webs and Climate Changes

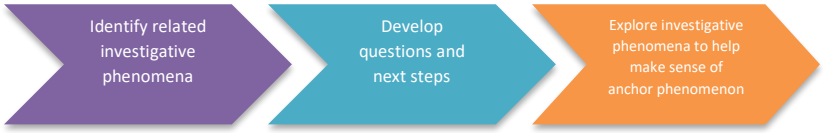
Questions students may pose that could be used for future learning or investigations:

Try to make sense of the anchor phenomenon

- What causes the harmful algal blooms to form?
- What impact do algal blooms have on aquatic ecosystems?
- How are humans impacted by algal blooms?
- Are seafood resources negatively impacted by algal blooms?
- How do ecosystems recover after experiencing harmful algal blooms?
- What can humans do to eliminate or reduce harmful algal blooms from forming?
- Where else in the world do algal blooms form?

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

Sample Investigative Phenomena



Sample 1: An Ebola break out that occurred in West Africa in 2014.

- The New York Times: Burial Boys of Ebola Virus Outbreak 2014
- BBC News: Why Ebola is so Dangerous
- Scientific American: Are Viruses Alive?

Sample questions for students to investigate:

- Are viruses alive? Use evidence from your investigation to support your response.
- What conditions allowed the Ebola virus in West Africa in 2014 to thrive?
- How are viruses and algal blooms similar and different?

3-D learning opportunities:

SEP: Plan and carry out an investigation

DCI: MS.LS1A.a

CC: Scale, proportion and quantity

Sample 2: Phytoplankton produce their own food.

- Forests of the Sea: Phytoplankton and Marine Plants
- NOAA: What are Phytoplankton?

Sample questions for students to investigate:

- In what type of environment do phytoplankton thrive?
- How do phytoplankton produce food?
- Why do phytoplankton cells have different parts?
- Do the cell parts have different functions?
- What causes phytoplankton to grow out of control?
- Are cells of all living things the same as phytoplankton cells?

3-D learning opportunities:

SEP: Plan and carry out an investigation

SEP: Develop and use a model

SEP: Construct an Explanation and design a solution

DCI: MS.LS1A.a

CC: Scale, proportion and quantity

CC: Structure and Function

Sample 3: Phytoplankton support oceanic life.

- Tiny Phytoplankton Have Big Influence on Climate Change
- The Secret Life of Plankton
- The Power of Plankton

Sample questions for students to investigate:

- What resources support phytoplankton?
- What animals directly rely on phytoplankton and which ones indirectly rely on phytoplankton?
- How does an increase or decrease of phytoplankton in an environment impact other species?
- How do phytoplankton support the flow of energy and matter into and out of living and nonliving parts of an ecosystem?
- How are food chains, food webs and energy pyramids used to demonstrate the flow of energy in an ecosystem?
- How does an overgrowth of phytoplankton disrupt the flow of energy and matter in aquatic ecosystems?

3-D learning opportunities:

SEP: Develop and use a model

SEP: Construct an Explanation

DCI: MS.LS2B.a; MS.LS2B.b; MS.LS2B.c

CC: Energy and Matter

Sample 4: Zebra mussels, an invasive species, out-compete natural organisms for resources in Lake Erie.

- The Effect of Zebra Mussels on Lake Erie
- Striped Invaders: Lake Erie's 20-Year Battle with Zebra Mussels
- Lake Erie's Toxic Algal Bloom
- Will Recycling Phosphorus Help Stop Algae Blooms?

Sample questions for students to investigate:

- How has the introduction of zebra mussels by humans impacted the ecosystem?
- How have the zebra mussels changed the flow of energy and matter in Lake Erie?
- How have zebra mussels, an invasive species, contributed to the formation of algal blooms?
- How have algal blooms impacted the ecosystem?
- What solutions could you pose that may help to rebalance the Lake Erie and the Yellow Sea ecosystems? Develop a model that illustrates the expected impact of your solution.

3-D learning opportunities:

SEP: Develop and use a model

DCI: MS.LS2B.a; MS.LS2B.b; MS.LS2B.c; MS.LS2B.d

CC: Energy and Matter

Sample Anchor Phenomenon Reflections

- What impacts do algal blooms have on the ecosystems in China and other areas?

Communicate scientific reasoning around the anchor phenomenon

- What role do phytoplankton play in the Yellow Sea turning green?
- How do the cellular structures and functions allow algal blooms to grow?
- How have humans altered environments in such a way that the growth of algal blooms occur?
- What solutions may impact the overgrowth of algal blooms?

Unit 6: Interdependent Relationships

About the Standards

Performance Expectations

- 6-MS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- 6-MS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
- 6-MS-ESS3-4 Earth and Human Activity Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Science and Engineering Practices

- Analyze and interpret data to provide evidence for phenomena.
- Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena.
- Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

Crosscutting Concepts

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- Patterns can be used to identify cause and effect relationships.

Putting the Standards into Practice

Sample Anchor Phenomenon: The Great Barrier Reef is turning white.

Explore the anchor phenomenon

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 sixth 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.

Coral Bleaching Happens Before Your Eyes
Rising Ocean Temperatures Are Cooking Coral Reefs
When Corals Met Algae
The Fish that Lives in a Sea Cumber Anus
Read Works: The Great Barrier Reef
Ted Talk: Why I Still Have Hope for Coral Reefs

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

Try to make sense of the anchor phenomenon

- Why are coral reefs turning white? What causes this?
- Can coral reefs recover after they are bleached?
- Are other organisms dying as a result of coral bleaching?
- What is the relationship between the survival of organisms and the availability of resources?
- How is the availability of resources driving predatory, competitive and mutualistic relationships in an ecosystem?
- How do human activities contribute to coral bleaching?
- How does the temperature of water impact coral reefs' ability to use symbiotic algae?
- What symbiotic relationships exist within the Great Barrier Reef?
- How do symbiotic relationships benefit organisms?
- How do predatory interactions limit the resources available within the Great Barrier Reef?

Teachers 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

- How does coral bleaching impact the availability of resources and populations of organisms living within the Great Barrier Reef?
- Construct an explanation supported by evidence that the patterns of interactions among organisms in the Great Barrier Reef are impacted by coral bleaching.
- Construct an argument with evidence that human population and their per-capita consumption of natural resources are impacting Earth's systems and contributing to coral bleaching.

Unit 7: Sound

About the Standards

Performance Expectations

- 6-MS-PS4-1 Waves and Their Applications in Technologies for Information Transfer: Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave and how the frequency and wavelength change the expression of the wave.
- 6-MS-PS4-2 Waves and Their Applications in Technologies for Information Transfer: Develop and use a model to describe that waves are refracted, reflected, absorbed, transmitted, or scattered through various materials.

Science and Engineering Practices

- Use mathematical representations to describe and/or support scientific conclusions and design solutions.
- Develop and/or use a model to predict and/or describe phenomena.

Crosscutting Concepts

- Graphs, charts, and images can be used to identify patterns in data.
- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Putting the Standards into Practice

Sample Anchor Phenomenon: We can sense many different sounds from a distance.

Explore the anchor phenomenon

Resources: A fully aligned, high-quality unit published by Next Generation Science Storylines is linked here.

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

Try to make sense of the anchor phenomenon

Where does sound come from?
How do different objects make sound?
How are different sounds made?
How does sound travel?
How does sound move through different materials?
What exactly is moving through the materials?
Why do sounds get quieter the further I move from the sources?

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

Sample Anchor Phenomenon Reflections

Communicate scientific reasoning around the anchor phenomenon

- Describe a simple model for sound waves that includes how the amplitude of a wave is related to the energy in a wave and how the frequency and wavelength change the expression of the wave.
- Develop and use a model to describe that sound waves are refracted, reflected, absorbed, transmitted, or scattered through various materials.