Grade 4: Bundle 3

Bundle 3

Using Energy Transformations

Performance Expectations		
4-PS3-2, 4-PS3-4, 4-PS3-2, 4-PS3-3, 4-PS3-1, 4-PS3-4, 3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations **Constructing Explanations and Designing Solutions** **Asking Questions and Defining Problems**	**PS3.A (2): Definitions of Energy** **PS3.B (4): Conservations of Energy and Energy Transfer** **ETS1.A (4): Defining Engineering Problems** **PS3.B (2): Conservation of Energy and Energy Transfer** **PS3.A (2): Definitions of Energy** **PS3.C (2): Relationship Between Energy and Forces** **PS3.A (1): Definitions of Energy** **PS3.D (1): Energy in Chemical Processes and Everyday Life**	**Energy and Matter: Flows, Cycles and Conservation**

Bundle 3: Using Energy Transformations is composed of four scopes. Each of these scopes provides the students with an opportunity to build their knowledge and start forming ideas that will help them complete their mission at the end of this bundle and build toward a complete answer to their Anchoring Phenomena question. Students will begin by being introduced to their Anchoring Phenomena that introduces them to their bundle mission of developing an electrical warning system to alert astronauts on a spaceship of potential asteroid collisions.

The students will then move through multiple scopes in which they will learn the following concepts:

- Energy is present whenever there are moving objects, sound, light, or heat.
- Energy can be transferred from one object to another and into different forms.
- Energy can be transferred from place to place by moving objects or through sound, light, or electric currents.
- The faster an object is moving, the more energy it has.
- Energy can be stored until it needs to be transferred into another form.

The students will also engage in the Science and Engineering Practices and Crosscutting Concepts listed above throughout the scopes in this bundle.

Grade 4: Bundle 3 Snapshot

Anchoring Phenomena: Why is a collision dangerous to our ship, and how can we warn the crew?

Mission Goal: The students' mission is to develop an electrical warning system to alert astronauts on a spaceship of potential asteroid collisions.

Scope	Investigative Phenomena	Instructional Focus	Connection to Bundle Mission
Energy Transfer and Electric Currents 	How does energy move from one place to another?	Understand that electric currents can be transferred into different types of energy.	How could an asteroid warning system be designed using electricity?
Transfer of Energy in Collision 	How is energy transferred when objects collide with each other?	Know that energy conversions occur when two objects collide.	Describe the energy transfer that occurs when an asteroid collides with a spaceship.
Energy and Speed 	How is the speed of a moving object related to the energy it has to transfer to another object?	Describe how energy and speed are related. Explain how friction affects an object's speed.	Describe the characteristics of an asteroid that would be the most dangerous to a spaceship.
Using Stored Energy 	How is stored energy used?	Identify reasons for why it is important to store energy. Provide examples of how energy can be stored for later use.	What power source could the asteroid warning system have that could store energy to be transferred to electrical energy when needed?

Bundle 3: Scope 1

Energy Transfer and Electric Currents

Three-Dimensional Learning

Performance Expectations

4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
Assessment Boundary: Assessment does not include quantitative measurements of energy.

4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device. Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2) **Constructing Explanations and Designing Solutions** Apply scientific ideas to solve design problems. (4-PS3-4)	**PS3.A (2): Definitions of Energy** Energy can be moved from place to place by moving objects or through **sound, light, or electric currents**. **PS3.B (4): Conservations of Energy and Energy Transfer** Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. **ETS1.A (4): Defining Engineering Problems** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (secondary to 4-PS3-4)	**Energy and Matter: Flows, Cycles and Conservation** Energy can be transferred in various ways and between objects. (4-PS3-2), (4-PS3-4)

Bundle 3: Scope 1

Energy Transfer and Electric Currents

Three-Dimensional Learning

Disciplinary Core Ideas

- **PS3.A (2): Definitions of Energy**
  Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

- **PS3.B (4): Conservations of Energy and Energy Transfer**
  Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

- All the elements found in the Energy Transfer and Electric Currents scope are designed to address the subelements for PS3.A (2), PS3.B (4), and ETS1.A (4).
- Students begin the scope by observing various objects and identifying the types of energy they provide.
- Students go on to explore how energy works, using batteries; how energy can be transferred to other forms of energy; and how to design and conduct an investigation about electric currents or energy transfer.

Science and Engineering Practices

- **Planning and Carrying Out Investigations**
  Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (3-PS3-2)

- **Constructing Explanations and Designing Solutions**
  Apply scientific ideas to solve design problems. (4-PS3-4)

- In the Hook, students observe various objects and identify the types of energy they provide.
- In Explore 1, students conduct an investigation to determine how energy works by using batteries to make a light bulb light up and make a buzzer sound. They explain how they got their light bulb and buzzer to work properly.
- In Explore 2, students design a booth that will draw a crowd's attention by including as many examples as possible of electrical energy being transferred to other forms of energy. They create a plan and follow that plan to create their product.
- In Explore 3, students work collaboratively to design and conduct an investigation about electric currents or energy transfer. When they are finished, they analyze their designs.

Crosscutting Concepts

- **Energy and Matter: Flows, Cycles and Conservation**
  Energy can be transferred in various ways and between objects. (4-PS3-2), (4-PS3-4)

- In the Hook, students explain what forms of energy can be observed in everyday objects.
- In Explore 1, students describe their observations made during their investigation about ways energy can be transferred.
- In Explore 2, students identify how electricity was transferred through their design to provide power to their product.

ETS (Engineering, Technology and the Application of Science)

- 3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

- In Explore 2, students use the scientific knowledge they gained as well as the 21st Century Skill of collaboration to design a booth that has many examples of electrical energy being transferred to other forms of energy.

The above illustrates how we integrate the three dimensions through the scope. As we know that opportunities naturally occur to model other Crosscutting Concepts and Science and Engineering Practices in many ways, we only call out the ones directly aligned by the NGSS Framework here.

Bundle 3: Scope 1

Energy Transfer and Electric Currents

Prior Knowledge and Progression

PS3.A N/A

PS3.B By the end of Grade 2, students should know that sunlight warms Earth's surface.

Category	K-2	3-5	Middle School	High School
PS3.B Conservation of Energy and Energy Transfer	Sunlight warms Earth's surface.	Moving objects contain energy. The faster the object moves, the more energy it has. Energy can be moved from place to place by moving objects, or through sound, light, or electrical currents. Energy can be converted from one form to another form.	Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter.	Systems move toward stable states.
PS3.A Definitions of Energy	N/A	Moving objects contain energy. The faster the object moves, the more energy it has. Energy can be moved from place to place by moving objects, or through sound, light, or electrical currents. Energy can be converted from one form to another form.	Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter.	The total energy within a system is conserved. Energy transfer within and between systems can be described and predicted in terms of energy associated with the motion or configuration of particles (objects).

Bundle 3: Scope 1

Energy Transfer and Electric Currents

Scope Overview

This scope begins with the introduction to the student Investigative Phenomena in the Engage section. Students will use their Graphic Organizers as their note-taking devices to record the information gained in each section as they begin to form a conceptual model of the content as they move through the scope. The teacher uses the Accessing Prior Knowledge (APK) element to help pull out students' current knowledge levels as well as any preconceptions they have before beginning the scope. In this Energy Transfer and Electric Currents APK, students read the statements about electric current and energy and choose which one they agree with most. This will help uncover possible preconceptions students have before beginning the lesson. Teachers can keep any such preconceptions in mind as they move through the scope. The final element in the Engage section is the Hook. Here, students have their first experience with the content. They will build on their knowledge as they continue moving through the scope.

Students then dig deeper into the content through the three Explore activities. In Explore 1, students explore how energy works by using batteries to make a light bulb light up and make a buzzer sound. In Explore 2, students work collaboratively to design a booth that has many examples of electrical energy being transferred to other forms of energy. In Explore 3, students design and conduct an investigation about electric currents or energy transfer. Explore 1 includes a formative CER assessment to help the teacher gauge student understanding at that point. By the end of the Engage and Explore activities, students should be able to design and conduct an investigation about electric currents or energy transfer.

Students will continue to refine their knowledge of the content as they move through the elements in the Explain and Elaborate sections. Teachers can use any or all of the provided elements. We know that most classrooms have limited time, so teachers should choose the Explain and Elaborate elements that best fit the needs of their students. The teacher can then formally assess the students' understanding by using any of the three summative assessments provided in the Evaluate section. If the students require additional help gaining proficiency with the content, resources can be found in the Intervention section. Students who have achieved mastery of the concept can move over to the Acceleration pieces.

Documents are available to help the teacher assess the CCCs and SEPs taught in this scope. These are located in the Home section of each scope. Question prompts or artifacts to look for throughout the scope are provided, as well as sample answers to help the teacher plot students' understanding on the rubric. The information that is gathered on these forms can be used to track progress on the CCC and SEP Segment Inventory of Skills found in each bundle and on the CCC and SEP Yearlong Inventory of Skills document located in the Teacher Toolbox.

Scope Snapshot: Energy Transfer and Electric Currents

Section	Element	Description
ENGAGE	Investigative Phenomena	How does electricity get to my house, and how does it help things work?
	APK	In this activity, students read the statements about electric current and energy and choose which one they agree with most.
	Graphic Organizer	The Graphic Organizer is a note-taking device students can use as they move through this scope.
	Hook	Students observe various objects and identify the types of energy they provide.
EXPLORE	Explore 1: Activity	**What's the Buzz?** Students explore how energy works by using batteries to make a light bulb light up and make a buzzer sound.
	Explore 2: Engineering Solution	**All the Bells and Whistles** Students use the scientific knowledge they gained as well as the 21st Century Skill of collaboration to design a booth that has many examples of electrical energy being transferred to other forms of energy.
	Explore 3: Inquiry Investigation	**My Energy Transfer Investigation** Students work in groups to design and conduct an investigation about electric currents or energy transfer.
EXPLAIN	Picture Vocabulary	A slide presentation of important vocabulary terms along with a picture and definition as well as a vocabulary activity in which students use vocabulary words to create an illustration
	STEMscopedia	Expository text to support science content, which can be used as reference material in conjunction with Linking Literacy activities
	Linking Literacy	Strategies to help students comprehend the informational text in the STEMscopedia, including pre-, during-, and post-reading activities
	Communicate Science	Students use different forms of communication to discuss scientific topics connected to the content of this scope.
	Concept Review Game	An interactive game that can be played as a class or individually to help students review the science concepts in the module
	Content Connections Video	An inquiry video that engages students and provides meaning

ELABORATE	Math Connections	A practice that uses grade-level-appropriate math activities to address the concept
	Reading Science: Three Lexile Levels (A, B, and C)	**Two Kinds of Current** This provides additional expository text that supports real-world application of the content, including five to eight comprehension questions. Teachers can choose which level to assign each student based on students' reading Lexile levels.
	Science Today: Watch It!	**Solar Energy** Students explore real-world connections and applications of science content through interactions with an engaging video provided by the Associated Press.
	Career Connections	**Heat Shield Engineer** A video that introduces students to STEM careers and the 21st Century Skills needed to succeed in those fields
	Scientist Spotlight	**Fred Begay** – Physicist
EVALUATE	Claim-Evidence-Reasoning	As Lea buttered her toast, she wondered where the energy in her toaster came from. Her town's main electrical source is a local wind turbine farm. The wind turbines turn and cause the generator to spin and create electricity. This electrical energy is then sent to the town's homes through power lines. Look at the diagram below to see how the energy travels from the wind turbines to an appliance. Write a scientific explanation for how the moving blades of the wind turbine help the toaster work.
	Open-Ended Response Assessment	A short-answer and essay assessment to evaluate students' mastery of the concept
	Multiple Choice Assessment	A standards-based assessment designed to gauge students' understanding of the science concept by using their selections of the best possible answers from a list of choices
INTERVENTION	Guided Practice	Students complete a circuit that lights a bulb, sounds a buzzer or bell, or turns a small propeller or motor. Students identify the energy transformation.
	Independent Practice	A short-answer and essay assessment to evaluate students' mastery of the concept
	Concept Attainment Quiz	A standards-based assessment designed to gauge students' understanding of the science concept by using their selections of the best possible answers from a list of choices
ACCELERATION	Extensions	A set of ideas and activities that can help further elaborate on the concept
	Books on Topic	A list of trade books for the scope
	Science Art	Students create a lighted art box with disappearing artwork.

Bundle 3: Scope 2

Transfer of Energy in Collision

Three-Dimensional Learning

Performance Expectations

4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
Assessment Boundary: Assessment does not include quantitative measurements of energy.

4-PS3-3 Ask questions and predict outcomes about the changes in energy that occur when objects collide.
Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact. Assessment Boundary: Assessment does not include quantitative measurements of energy.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3) **Planning and Carrying Out Investigations** Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2)	**PS3.B (2): Conservation of Energy and Energy Transfer** Energy is present whenever there are **moving objects,** sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. **PS3.A (2): Definitions of Energy** Energy can be moved from place to place by **moving objects** or through sound, light, or electric currents **PS3.C (2): Relationship Between Energy and Forces** When objects collide, the contact forces transfer energy so as to change the object's' motions.	**Energy and Matter: Flows, Cycles and Conservation** Energy can be transferred in various ways and between objects. (4-PS3-2), (4-PS3-3)

Bundle 3: Scope 2

Transfer of Energy in Collision

Three-Dimensional Learning

Disciplinary Core Ideas

- **PS3.B (2): Conservation of Energy and Energy Transfer**
  Energy is present whenever there are **moving objects**, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result the air gets heated and sound is produced.
- **PS3.A (2): Definitions of Energy**
  Energy can be moved from place to place by **moving objects** or through sound, light, or electric currents.
- **PS3.C (2): Relationship Between Energy and Forces**
  When objects collide, the contact forces transfer energy so as to change the object's' motions.

- All the elements found in the Transfer of Energy in Collision scope are designed to address the subelements for PS3.B (2), PS3.A (2), and PS3.C (2). Students begin the scope by observing what happens when marbles collide. They go on to explore how energy is transferred when objects collide, observe what happens when they bounce different balls near differently weighted objects, and, finally, design and construct a collision machine.

Science and Engineering Practices

- **Asking Questions and Defining Problems**
  Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3)
- **Planning and Carrying Out Investigations**
  Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2)

- In Explore 1, students investigate how energy is transferred when objects collide. They have an opportunity, if time permits, to investigate more of their own ideas and questions.
- In Explore 2, students plan and conduct an investigation in which they observe what happens when they bounce different balls near differently weighted objects.
- In Explore 3, student groups follow a plan to design their product. They are prepared to answer questions about their design.

Crosscutting Concepts

- **Energy and Matter: Flows, Cycles and Conservation**
  Energy can be transferred in various ways and between objects. (4-PS3-2), (4-PS3-3)

- In Explore 1, students explain how energy is transferred during their investigation.
- In Explore 2, students hypothesize about why the falling ball made the objects move.
- In Explore 3, students answer questions about the collisions that occurred and how energy was transferred.

ETS (Engineering, Technology and the Application of Science)

- 3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

- In Explore 3, students use the scientific knowledge they have gained as well as the 21st Century Skill of collaboration to design and construct a collision machine.

The above illustrates how we integrate the three dimensions through the scope. As we know that opportunities naturally occur to model other Crosscutting Concepts and Science and Engineering Practices in many ways, we only call out the ones directly aligned by the NGSS Framework here.

Bundle 3:
Scope 2

Transfer of Energy in Collision

Prior Knowledge and Progression

PS3.B

By the end of Grade 2, students should know that sunlight warms Earth's surface.

PS3.A

By the end of Grade 2. N/A

PS3.C

By the end of Grade 2, students should know that a bigger push or pull makes things go faster and that faster speeds during a collision can cause a bigger change in shape of the colliding objects.

Category	K-2	3-5	Middle School	High School
PS3.B Conservation of Energy and Energy Transfer	Sunlight warms Earth's surface.	Moving objects contain energy. The faster the object moves, the more energy it has. Energy can be moved from place to place by moving objects, or through sound, light, or electrical currents. Energy can be converted from one form to another form.	Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter.	Systems move toward stable states.
PS3.A Definitions of Energy	N/A	Moving objects contain energy. The faster the object moves, the more energy it has. Energy can be moved from place to place by moving objects, or through sound, light, or electrical currents. Energy can be converted from one form to another form.	Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter.	The total energy within a system is conserved. Energy transfer within and between systems can be described and predicted in terms of energy associated with the motion or configuration of particles (objects).
PS3.C Relationship Between Energy and Forces	Bigger pushes and pulls cause bigger changes in an object's motion or shape.	When objects collide, contact forces transfer energy so as to change the objects' motions.	When two objects interact, each one exerts a force on the other, and these forces can transfer energy between them.	Fields contain energy that depends on the arrangement of the objects in the field.

Bundle 3: Scope 2

Transfer of Energy in Collision

Scope Overview

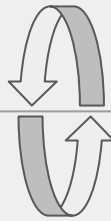
This scope begins with the introduction to the student Investigative Phenomena in the Engage section. Students will use their Graphic Organizers as their note-taking devices to record the information gained in each section as they begin to form a conceptual model of the content as they move through the scope. The teacher uses the Accessing Prior Knowledge (APK) element to help pull out students' current knowledge levels as well as any preconceptions they have before beginning the scope. In this Transfer of Energy in Collision APK, students must think about what happens to the energy of an object when it collides with another object. This will help uncover possible preconceptions students have before beginning the lesson. Teachers can keep any such preconceptions in mind as they move through the scope. The final element in the Engage section is the Hook. Here, students have their first experience with the content. They will build on their knowledge as they continue moving through the scope.

Students then dig deeper into the content through the three Explore activities. In Explore 1, they investigate how energy is transferred when objects collide. In Explore 2, students bounce different balls near differently weighted objects and observe what happens. In Explore 3, students work collaboratively to design and construct a collision machine. Explores 1 and 2 include a formative CER assessment to help the teacher gauge student understanding at that point. By the end of the Engage and Explore activities, students should be able to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. In addition, they will be able to ask questions and predict outcomes about the changes in energy that occur when objects collide.

Students will continue to refine their knowledge of the content as they move through the elements in the Explain and Elaborate sections. Teachers can use any or all of the provided elements. We know that most classrooms have limited time, so teachers should choose the Explain and Elaborate elements that best fit the needs of their students. The teacher can then formally assess the students' understanding by using any of the three summative assessments provided in the Evaluate section. If the students require additional help gaining proficiency with the content, resources can be found in the Intervention section. Students who have achieved mastery of the concept can move over to the Acceleration pieces.

Documents are available to help the teacher assess the CCCs and SEPs taught in this scope. These are located in the Home section of each scope. Question prompts or artifacts to look for throughout the scope are provided, as well as sample answers to help the teacher plot students' understanding on the rubric. The information that is gathered on these forms can be used to track progress on the CCC and SEP Segment Inventory of Skills found in each bundle and on the CCC and SEP Yearlong Inventory of Skills document located in the Teacher Toolbox.

Scope Snapshot: Transfer of Energy in Collision

Section	Element	Description
ENGAGE	Investigative Phenomena	What happens to the bowling ball's energy as it rolls into the pins?
	APK	Students think about what happens to the energy of an object when it collides with another object.
	Graphic Organizer	The Graphic Organizer is a note-taking device students can use as they move through this scope.
	Hook	Students observe what happens when marbles collide.
EXPLORE	Explore 1: Activity	**When Cars Collide** Students investigate how energy is transferred when objects collide.
	Explore 2: Scientific Investigation	**Let's Bounce** Students bounce different balls near differently weighted objects and observe what happens.
	Explore 3: Engineering Solution	**Collision Machine** Students use the scientific knowledge they have gained as well as the 21st Century Skill of collaboration to design and construct a collision machine.
EXPLAIN	Picture Vocabulary	A slide presentation of important vocabulary terms along with a picture and definition as well as a vocabulary activity in which students use vocabulary words to create an illustration
	STEMscopedia	Expository text to support science content, which can be used as reference material in conjunction with Linking Literacy activities
	Linking Literacy	Strategies to help students comprehend the informational text in the STEMscopedia, including pre-, during-, and post-reading activities
	Communicate Science	Students use different forms of communication to discuss scientific topics connected to the content of this scope.
	Concept Review Game	An interactive game that can be played as a class or individually to help students review the science concepts in the module
	Content Connections Video	An inquiry video that engages students and provides meaning

ELABORATE	Math Connections	A practice that uses grade-level-appropriate math activities to address the concept
	Reading Science: Three Lexile Levels (A, B, and C)	**Crater Creation** This provides additional expository text that supports real-world application of the content, including five to eight comprehension questions. Teachers can choose which level to assign each student based on students' reading Lexile levels.
	Science Today: Watch It!	**Tennis** Students explore real-world connections and applications of science content through interactions with an engaging video provided by the Associated Press.
	Career Connections	**Heat Shield Engineer** A video that introduces students to STEM careers and the 21st Century Skills needed to succeed in those fields
	Scientist Spotlight	**Olga D. González-Sanabria** – Chemical Engineer
	SEP Simulations	**Transfer of Energy in Collision** Students interact with Science and Engineering Practices by manipulating on-screen elements in this performance-based assessment.
EVALUATE	Claim-Evidence-Reasoning	A class took a field trip to a bowling alley. They noticed several energy transfers as they bowled. Write a scientific explanation for what happens when the bowling ball makes contact with the pins.
	Open-Ended Response Assessment	A short-answer and essay assessment to evaluate students' mastery of the concept
	Multiple Choice Assessment	A standards-based assessment designed to gauge students' understanding of the science concept by using their selections of the best possible answers from a list of choices
INTERVENTION	Guided Practice	Students explore collisions from various distances and angles.
	Independent Practice	A short-answer and essay assessment to evaluate students' mastery of the concept
	Concept Attainment Quiz	A standards-based assessment designed to gauge students' understanding of the science concept by using their selections of the best possible answers from a list of choices
ACCELERATION	Extensions	A set of ideas and activities that can help further elaborate on the concept
	Books on Topic	A list of trade books for the scope
	Science Art	Students create a picture book that demonstrates energy transfer.

Bundle 3: Scope 3

Energy and Speed

Three-Dimensional Learning

Performance Expectations
4-PS3-1 Use evidence to construct an explanation relating the speed of an object to the energy of that object. Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1)	**PS3.A (1): Definitions of Energy** The faster a given object is moving, the more energy it possesses.	**Energy and Matter: Flows, Cycles and Conservation** Energy can be transferred in various ways and between objects. (4-PS3-1)

Disciplinary Core Ideas	
• **PS3.A (1): Definitions of Energy** The faster a given object is moving, the more energy it possesses.	• All the elements found in the Energy and Speed scope are designed to address the subelement for PS3.A (1). Students begin the scope by determining when they used the greatest and least amount of energy while walking, jogging, and running across an open area. They go on to explore how the height of a ramp affects the distance an object travels as well as the sound produced when two objects collide. In addition, they construct a climber and observe and record how speed and energy are related.
Science and Engineering Practices	
• **Constructing Explanations and Designing Solutions** Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1)	• In Explore 1, students explain how the height of a ramp affects the distance an object travels as well as the sound produced when two objects collide in an investigation. • In Explore 2, students make observations and take measurements while racing a spider (or other climbing animal) to the top of a string. They then construct explanations about the relationship between energy and speed.
Crosscutting Concepts	
• **Energy and Matter: Flows, Cycles and Conservation** Energy can be transferred in various ways and between objects. (4-PS3-1)	• In Explore 1, students describe the sound created by the jingle bell when the objects collided. • In Explore 2, students explain the type of energy transferred to the climber they create.

The above illustrates how we integrate the three dimensions through the scope. As we know that opportunities naturally occur to model other Crosscutting Concepts and Science and Engineering Practices in many ways, we only call out the ones directly aligned by the NGSS Framework here.

Bundle 3: Scope 3

Energy and Speed

Prior Knowledge and Progression

By the end of Grade 2: N/A

Category	K-2	3-5	Middle School	High School
PS3.A Definitions of Energy	N/A	Moving objects contain energy. The faster the object moves, the more energy it has. Energy can be moved from place to place by moving objects, or through sound, light, or electrical currents. Energy can be converted from one form to another form.	Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter.	The total energy within a system is conserved. Energy transfer within and between systems can be described and predicted in terms of energy associated with the motion or configuration of particles (objects).

Scope Overview

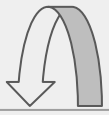
This scope begins with the introduction to the student Investigative Phenomena in the Engage section. Students will use their Graphic Organizers as their note-taking devices to record the information gained in each section as they begin to form a conceptual model of the content as they move through the scope. The teacher uses the Accessing Prior Knowledge (APK) element to help pull out students' current knowledge levels as well as any preconceptions they have before beginning the scope. In this Energy and Speed APK, students choose the statement they agree with most regarding the relationship between the speed of a ball and the energy used to move the ball. This will help uncover possible preconceptions students have before beginning the lesson. Teachers can keep any such preconceptions in mind as they move through the scope. The final element in the Engage section is the Hook. Here, students have their first experience with the content. They will build on their knowledge as they continue moving through the scope.

Students then dig deeper into the content through the two Explore activities. In Explore 1, they investigate how the height of a ramp affects the distance an object travels as well as the sound produced when two objects collide. In Explore 2, students construct a climber and observe and record how speed and energy are related. Explore 1 includes a formative CER assessment to help the teacher gauge student understanding at that point. By the end of the Engage and Explore activities, students should be able to construct a climber and observe and record how speed and energy are related.

Students will continue to refine their knowledge of the content as they move through the elements in the Explain and Elaborate sections. Teachers can use any or all of the provided elements. We know that most classrooms have limited time, so teachers should choose the Explain and Elaborate elements that best fit the needs of their students. The teacher can then formally assess the students' understanding by using any of the three summative assessments provided in the Evaluate section. If the students require additional help gaining proficiency with the content, resources can be found in the Intervention section. Students who have achieved mastery of the concept can move over to the Acceleration pieces.

Documents are available to help the teacher assess the CCCs and SEPs taught in this scope. These are located in the Home section of each scope. Question prompts or artifacts to look for throughout the scope are provided, as well as sample answers to help the teacher plot students' understanding on the rubric. The information that is gathered on these forms can be used to track progress on the CCC and SEP Segment Inventory of Skills found in each bundle and on the CCC and SEP Yearlong Inventory of Skills document located in the Teacher Toolbox.

Scope Snapshot: Energy and Speed

Section	Element	Description
ENGAGE	Investigative Phenomena	How is the speed of a moving bat related to the energy it transfers to a baseball?
	APK	In this activity, students choose the statement they agree with most regarding the relationship between the speed of a ball and the energy used to move the ball.
	Graphic Organizer	The Graphic Organizer is a note-taking device students can use as they move through this scope.
	Hook	After walking, jogging, and running across an open area, students determine when they used the greatest and least amount of energy.
EXPLORE 	Explore 1: Scientific Investigation	**Racing for Distance** Students investigate how the height of a ramp affects the distance an object travels as well as the sound produced when two objects collide.
	Explore 2: Activity	**Creepy Crawlers** Students will construct a climber and observe and record how speed and energy are related.
EXPLAIN 	Picture Vocabulary	A slide presentation of important vocabulary terms along with a picture and definition as well as a vocabulary activity in which students use vocabulary words to create an illustration
	STEMscopedia	Expository text to support science content, which can be used as reference material in conjunction with Linking Literacy activities
	Linking Literacy	Strategies to help students comprehend the informational text in the STEMscopedia, including pre-, during-, and post-reading activities
	Communicate Science	Students use different forms of communication to discuss scientific topics connected to the content of this scope.
	Concept Review Game	An interactive game that can be played as a class or individually to help students review the science concepts in the module
	Content Connections Video	An inquiry video that engages students and provides meaning

ELABORATE	Math Connections	A practice that uses grade-level-appropriate math activities to address the concept
	Reading Science: Three Lexile Levels (A, B, and C)	**A Winning Force** This provides additional expository text that supports real-world application of the content, including five to eight comprehension questions. Teachers can choose which level to assign each student based on students' reading Lexile levels.
	Science Today: Watch It!	**Motorcycles** Students explore real-world connections and applications of science content through interactions with an engaging video provided by the Associated Press.
	Career Connections	**Heat Shield Engineer** A video that introduces students to STEM careers and the 21st Century Skills needed to succeed in those fields
	Scientist Spotlight	**John Paul Stapp** – Air Force Officer
	PhET: Simulation Practice	**Forces and Motion: Basics** Explore the forces at work when pulling against a cart and pushing a refrigerator, crate, or person. Create an applied force and see how it makes objects move. Change friction and see how it affects the motion of objects.
EVALUATE	Claim-Evidence-Reasoning	At a baseball game, Tommy noticed that when the batter swung the bat very fast and the bat connected with the ball, the ball rocketed off the bat. When the batter bunted (barely tapped) the ball with the bat, the ball fell to the ground. Tommy noticed there was a relationship between the speed the batters swung their bats and the amount of energy that was transferred to the balls. Write a scientific explanation for which type of swing had the most energy.
	Open-Ended Response Assessment	A short-answer and essay assessment to evaluate students' mastery of the concept
	Multiple Choice Assessment	A standards-based assessment designed to gauge students' understanding of the science concept by using their selections of the best possible answers from a list of choices
INTERVENTION	Guided Practice	Students determine which ball has more energy by observing the movement and sound created as energy is transferred.
	Independent Practice	A short-answer and essay assessment to evaluate students' mastery of the concept
	Concept Attainment Quiz	A standards-based assessment designed to gauge students' understanding of the science concept by using their selections of the best possible answers from a list of choices
ACCELERATION	Extensions	A set of ideas and activities that can help further elaborate on the concept
	Books on Topic	A list of trade books for the scope
	Science Art	Students create a flip-book to show how force can cause an object to speed up, slow down, or change direction.

Bundle 3:
Scope 4

Using Stored Energy

Three-Dimensional Learning

Performance Expectations
4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device. Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound. **3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.**

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Apply scientific ideas to solve design problems. (4-PS3-4)	**PS3.D (1): Energy in Chemical Processes and Everyday Life** The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use.	**Energy and Matter: Flows, Cycles and Conservation** Energy can be transferred in various ways and between objects. (4-PS3-4)

Bundle 3: Scope 4

Using Stored Energy

Three-Dimensional Learning

Disciplinary Core Ideas	
• **PS3.D (1): Energy in Chemical Processes and Everyday Life** The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.	• All the elements found in the Using Stored Energy scope are designed to address the subelement for PS3.D (1). Students begin the scope by observing how objects that are used for similar purposes have different amounts of stored energy. They go on to explore how stored energy can be converted into a desired form for practical use. In addition, they analyze energy conversion in various forms of transportation.
Science and Engineering Practices	
• **Constructing Explanations and Designing Solutions** Apply scientific ideas to solve design problems.	• In Part I of Explore 1, students build a turbine to answer the question "How can stored energy be converted into forms used for practical use?" In Part II of Explore 1, students build circuits using various sizes of batteries to see how the brightness of a light is affected by using various amounts of stored energy. • In Explore 2, students will discuss why they think it is necessary for forms of transportation to have a way to store energy.
Crosscutting Concepts	
• **Energy and Matter: Flows, Cycles and Conservation** Energy can be transferred in various ways and between objects.	• In the Hook, the teacher explains that the match and the lighter have chemicals that can be burned to release heat energy we can use. • In Explore 1, students explain the relationship between the amount of stored energy and the amount of energy released. • In Explore 2, students analyze energy conversion in various forms of transportation. They hold an in-depth class discussion about energy conversions.

ETS (Engineering, Technology and the Application of Science)	
• 3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	• In Explore 1, students investigate how stored energy can be converted into a desired form for practical use.

The above illustrates how we integrate the three dimensions through the scope. As we know that opportunities naturally occur to model other Crosscutting Concepts and Science and Engineering Practices in many ways, we only call out the ones directly aligned by the NGSS Framework here.

Bundle 3: Scope 4

Using Stored Energy

Prior Knowledge and Progression

By the end of Grade 2, students should know that when two objects rub against each other, this interaction is called friction. Friction between two surfaces can warm both of them (e.g., rubbing hands together). There are ways to reduce the friction between two objects.

Category	K-2	3-5	Middle School	High School
PS3.D Energy in Chemical Processes and Everyday Life	Sunlight warms Earth's surface.	Energy can be "produced," "used," or "released" by converting stored energy. Plants capture energy from sunlight, which can later be used as fuel or food.	Sunlight is captured by plants and used in a reaction to produce sugar molecules, which can be reversed by burning those molecules to release energy.	Photosynthesis is the primary biological means of capturing radiation from the sun; energy cannot be destroyed, it can be converted to less useful forms.

Scope Overview

This scope begins with the introduction to the student Investigative Phenomena in the Engage section. Students will use their Graphic Organizers as their note-taking devices to record the information gained in each section as they begin to form a conceptual model of the content as they move through the scope. The teacher uses the Accessing Prior Knowledge (APK) element to help pull out students' current knowledge levels as well as any preconceptions they have before beginning the scope. In this Using Stored Energy APK, students choose the statement about stored energy they agree with most. This will help uncover possible preconceptions students have before beginning the lesson. Teachers can keep any such preconceptions in mind as they move through the scope. The final element in the Engage section is the Hook. Here, students have their first experience with the content. They will build on their knowledge as they continue moving through the scope.

Students then dig deeper into the content through the two Explore activities. In Explore 1, they investigate how stored energy can be converted into a desired form for practical use. In Explore 2, students analyze energy conversion in various forms of transportation. Explore 2 includes a formative CER assessment to help the teacher gauge student understanding at that point. By the end of the Engage and Explore activities, students should be able to apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Students will continue to refine their knowledge of the content as they move through the elements in the Explain and Elaborate sections. Teachers can use any or all of the provided elements. We know that most classrooms have limited time, so teachers should choose the Explain and Elaborate elements that best fit the needs of their students. The teacher can then formally assess the students' understanding by using any of the three summative assessments provided in the Evaluate section. If the students require additional help gaining proficiency with the content, resources can be found in the Intervention section. Students who have achieved mastery of the concept can move over to the Acceleration pieces.

Documents are available to help the teacher assess the CCCs and SEPs taught in this scope. These are located in the Home section of each scope. Question prompts or artifacts to look for throughout the scope are provided, as well as sample answers to help the teacher plot students' understanding on the rubric. The information that is gathered on these forms can be used to track progress on the CCC and SEP Segment Inventory of Skills found in each bundle and on the CCC and SEP Yearlong Inventory of Skills document located in the Teacher Toolbox.

Scope Snapshot: Using Stored Energy

Section	Element	Description
ENGAGE	Investigative Phenomena	If something is not plugged in, how is it lighting up?
	APK	Students choose the statement about stored energy they agree with most.
	Graphic Organizer	The Graphic Organizer is a note-taking device students can use as they move through this scope.
	Hook	Students observe how objects that are used for similar purposes have different amounts of stored energy.
EXPLORE 	Explore 1: Scientific Investigation	**More Energy, Please!** Students investigate how stored energy can be converted into a desired form for practical use.
	Explore 2: Activity	**History of Transportation** Students observe what happens when marbles collide.
EXPLAIN	Picture Vocabulary	A slide presentation of important vocabulary terms along with a picture and definition as well as a vocabulary activity in which students use vocabulary words to create an illustration
	STEMscopedia	Expository text to support science content, which can be used as reference material in conjunction with Linking Literacy activities
	Linking Literacy	Strategies to help students comprehend the informational text in the STEMscopedia, including pre-, during-, and post-reading activities
	Communicate Science	Students use different forms of communication to discuss scientific topics connected to the content of this scope.
	Concept Review Game	An interactive game that can be played as a class or individually to help students review the science concepts in the module
	Content Connections Video	An inquiry video that engages students and provides meaning

ELABORATE	Math Connections	A practice that uses grade-level-appropriate math activities to address the concept
	Reading Science: Three Lexile Levels (A, B, and C)	**A Wild Weather Day** This provides additional expository text that supports real-world application of the content, including five to eight comprehension questions. Teachers can choose which level to assign each student based on students' reading Lexile levels.
	Science Today: Read It!	**Wind Farm** Students explore real-world connections and applications of science content through interactions with an engaging video provided by the Associated Press.
	Career Connections	**Athletic Trainer** A video that introduces students to STEM careers and the 21st Century Skills needed to succeed in those fields
	Scientist Spotlight	**Lloyd Augustus Hall** – Chemist
EVALUATE	Claim-Evidence-Reasoning	Annalise got a metal toy monkey with moveable arms holding cymbals. The package said the toy could light up and that it would hit the cymbals together to make noise when it was turned on. Annalise turned it on. Nothing happened. Her mom opened the bottom, put batteries inside, and gave it back to Annalise. She turned it on again, and it worked! The lights started flashing and the cymbals started clanking! Use scientific reasoning to explain why Annalise's mom put batteries in the toy.
	Open-Ended Response Assessment	A short-answer and essay assessment to evaluate students' mastery of the concept
	Multiple Choice Assessment	A standards-based assessment designed to gauge students' understanding of the science concept by using their selections of the best possible answers from a list of choices
INTERVENTION	Guided Practice	Students play a game showing how energy can be changed into other types of energy, such as motion, light, or sound.
	Independent Practice	A short-answer and essay assessment to evaluate students' mastery of the concept
	Concept Attainment Quiz	A standards-based assessment designed to gauge students' understanding of the science concept by using their selections of the best possible answers from a list of choices
ACCELERATION	Extensions	A set of ideas and activities that can help further elaborate on the concept
	Books on Topic	A list of trade books for the scope
	Science Art	Students create light switch plates with images representing the forms of energy, using the template provided in Energy Forms: Light Switch Plate.