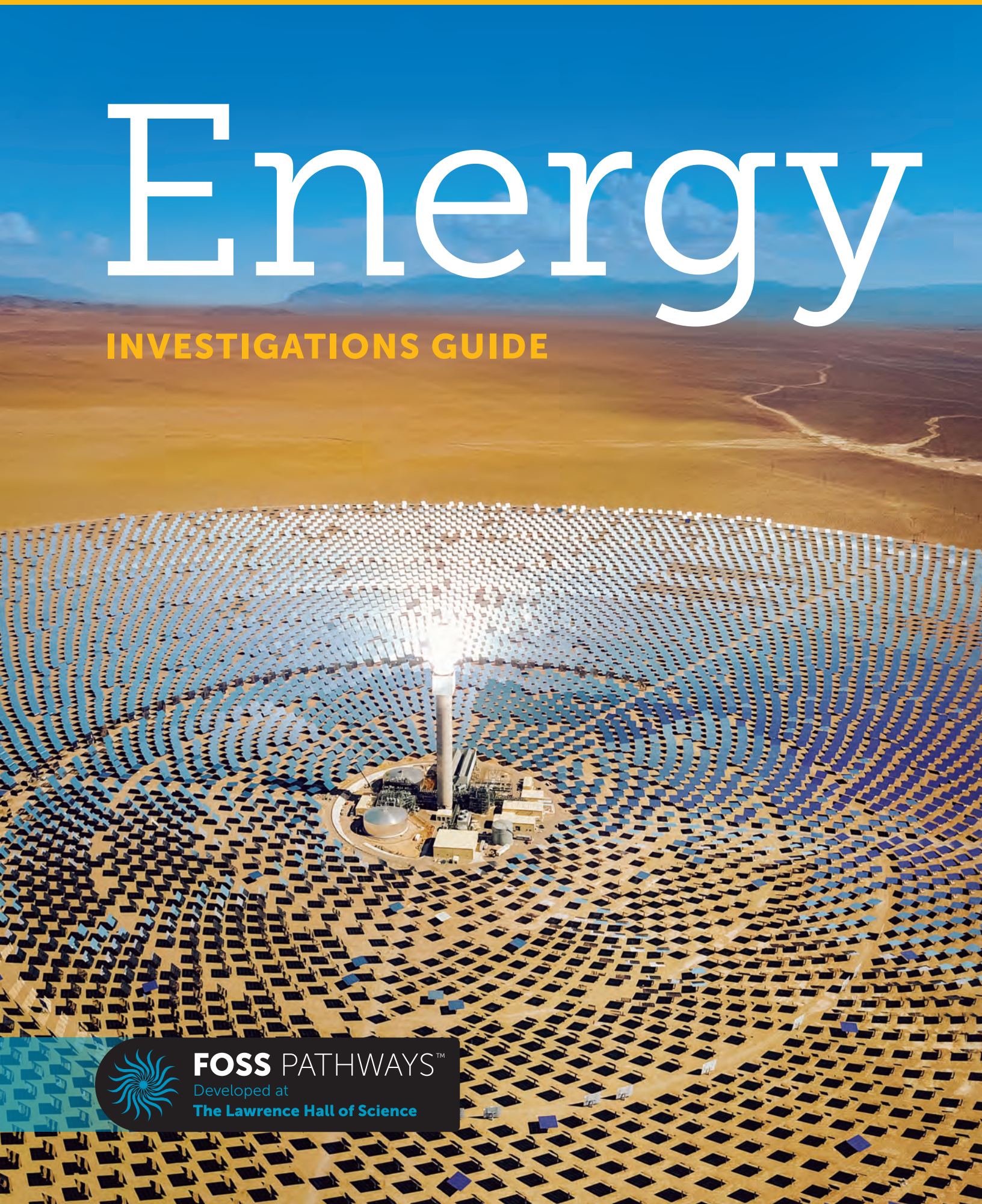
SAMPLER

Energy

INVESTIGATIONS GUIDE



FOSS PATHWAYS™
Developed at
The Lawrence Hall of Science

PreK–5 science that meets the challenge of our time

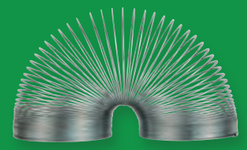
Welcome to new FOSS® Pathways™. Now as never before, the world needs scientific thinkers—to view the world thoughtfully, approach challenges analytically, and embrace opportunities enthusiastically. For educators to help unlock this potential in their students, they need powerful tools that work for the needs of today. A program that engages students of all backgrounds and experiences. Fully leverages modern digital technology. And does it all in the hours available.

A major advancement from a proven leader

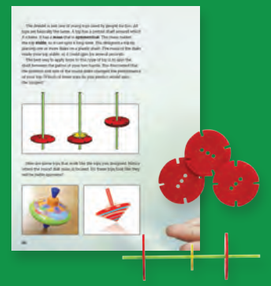
The Full Option Science System™ (FOSS) was conceived to enlist students not as passive recipients of information, but as active investigators of phenomena. That principle has proven its worth for 150,000 teachers and 4 million students across all 50 states, building a legacy of student engagement and test-score improvement. Now FOSS takes science education another significant step forward, with FOSS Pathways. This new PreK–5 core curriculum:

Aligns with today's national science standards and is adaptable to meet state and local requirements

Incorporates the digital tools for a flexible multimedia experience



Lends flexibility to teach in the class time allotted for science



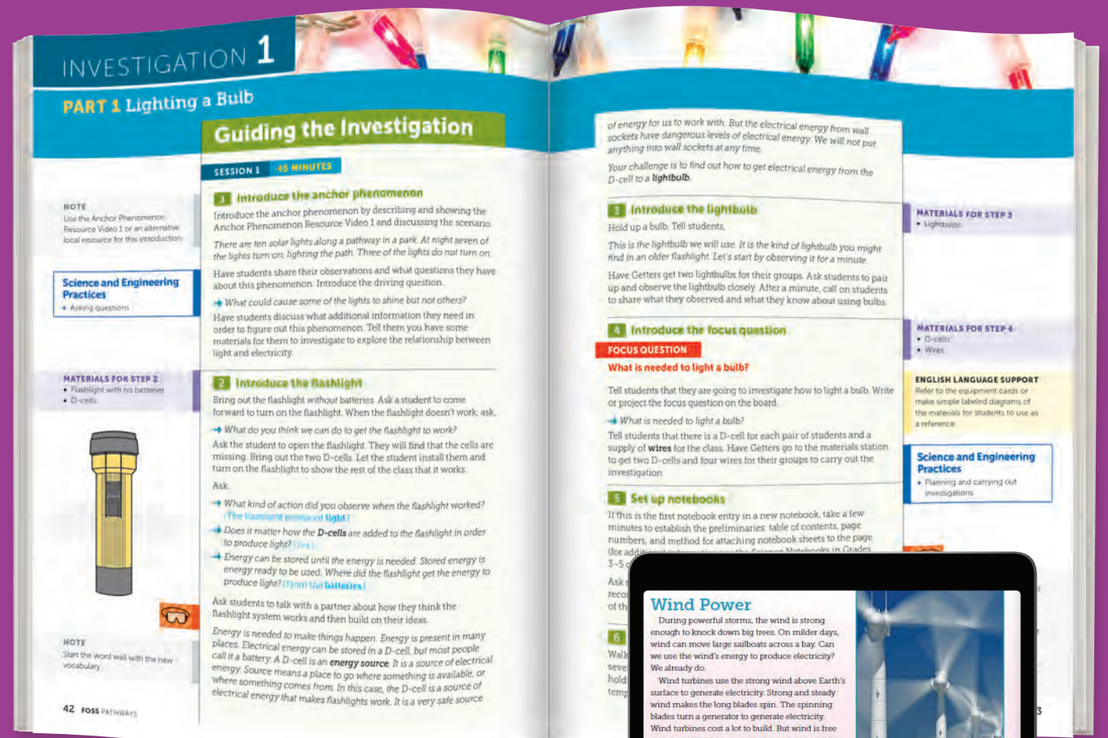
Teaches through a multimodal approach to resonate with every student

Engages students through coherent phenomenon storylines that are local and relevant

Provides unmatched educative support to teach phenomena-based science

How Pathways develops the scientific thinkers of tomorrow

New FOSS Pathways supports today's demand to develop scientifically literate thinkers and problem solvers in a multitude of ways.



A logical progression

Students develop core ideas in a relevant and coherent learning progression that allows them to construct an explanation of the phenomena they have experienced.

Support for students

Comprehensive support and multimodal instructional experiences engage learners of all languages and cultures, taking advantage of prior experiences so all students can reason scientifically.

Evidence of learning

Research-based and field-tested assessments accurately measure student learning and progress. A variety of formative assessment tools provide evidence of students' use of the three dimensions and their knowledge of phenomena.

Support for teachers

Phenomena-based instruction is facilitated by appropriate educative support. This includes explicit background information needed for teachers to engage students in making the connection between the anchor phenomenon being investigated and the core ideas being exposed.

Rich digital resources

Digital resources for students and teachers are provided through FOSSweb on ThinkLink™. These multimedia materials are purposefully designed to enhance the learning experience and lend the flexibility to keep active science teaching viable if classroom circumstances change.

How FOSS Pathways aligns with today's standards

In this Sampler, pages 9-21 and 23-49 are provided from the teacher *Investigations Guide*. As you review, you will begin to witness the numerous ways that FOSS Pathways supports the development of tomorrow's scientists, engineers, and informed citizens. You'll see examples for:

Investigations driven by local, relevant phenomena and real-world problems

Instruction led by multimodal experiences that cognitively engage students to figure out phenomena

Identification of performances to meet targeted learning goals and elicit evidence of students' use of all three dimensions

Instructional support for teachers that provides an explicit connection between the phenomenon, three-dimensional learning, and multimodal learning experiences

Clear integration of ELA/ELD skills and practices, with ties to standards and resources for engaging multilingual students

Cross-curricular activities that give students a choice and voice to differentiate instruction

▶ Images on this page include actual components, resources and/or materials provided in FOSS kits.

Alignment to NGSS Performance Expectations

Grade 4 NGSS Performance Expectations	Energy	
	Investigation(s)	Benchmark Assessment
4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.	**Investigation 3**	• Investigations 2-3 I-Check • Survey/Posttest
4-PS3-2. Make observations to provide evidence that energy can be transferred place to place by sound, light, heat, and electric currents.	**Investigation 1** **Investigation 2**	• Investigation 1 I-Check • Investigations 2-3 I-Check • Survey/Posttest
4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.	**Investigation 3**	• Investigations 2-3 I-Check • Survey/Posttest
4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	**Investigation 1** **Investigation 2**	• Investigation 1 I-Check • Investigations 2–3 I-Check • Survey/Posttest
4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.	**Investigation 4**	• Survey/Posttest
4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.	**Investigation 4**	• Survey/Posttest
4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.	**Investigation 2**	• Investigations 2-3 I-Check • Survey/Posttest
4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.	**Investigation 1**	• Survey/Posttest
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.	**Investigation 1** **Investigation 2**	• Survey/Posttest
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.	**Investigation 2**	• Survey/Posttest
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.	**Investigation 2**	• Survey/Posttest

Energy Investigations

Investigation 1: Energy and Circuits

Part 1: Lighting a Bulb
Part 2: Conductors and Circuits
Part 3: Design Circuits with Solar Cells

Investigation 2: Information Transfer Systems

Part 1: Building an Electromagnet
Part 2: Reinventing the Telegraph
Part 3: Comparing Systems

Investigation 3: Energy Transfer

Part 1: Rolling Balls Down Slopes
Part 2: Collisions

Investigation 4: Light and Waves

Part 1: Light Travels
Part 2: Forms of Waves

Energy

▶ Start here to begin your review of the Grade 4 Energy Investigations Guide

Introduction

The **Energy Module** has four investigations that focus on the concepts that energy is present whenever there is motion, electric current, sound, light, or heat, and that energy can transfer from one place to another. Five anchor phenomena drive the investigations.

- Anchor phenomenon 1—solar lights working and not working
- Anchor phenomenon 2—sending and receiving text messages
- Anchor phenomenon 3—knocking down bowling pins
- Anchor phenomenon 4—unable to see during power outage
- Anchor phenomenon 5—moving up and down

Students investigate electricity and magnetism as related effects and engage in engineering design to convert energy from one form to another. They gather information about how energy is derived from natural resources and how that affects the environment and explore alternative sources of energy such as solar energy.

They investigate how the amount of energy transfer changes when balls of different masses hit a stationary object. Students explore energy transfer through waves (repeating patterns of motion) that result in sound and motion.

Students interpret data to build explanations from evidence and make predictions of future events. They develop models to represent how energy moves from place to place in electric circuits and in waves. Students gain experiences that will contribute to the understanding of crosscutting concepts of patterns; cause and effect; systems and system models; and energy and matter.

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Introduction
Module Matrix
Conceptual Flow of Module
FOSS Pathways Teaching Schedule
FOSS Investigation Organization
The Elements of the FOSS Instructional Design
Diversity, Equity, and Inclusion
Establishing a Classroom Culture

The NGSS Performance Expectations bundled in this module include:

Physical Sciences
4-PS3-1
4-PS3-2
4-PS3-3
4-PS3-4
4-PS4-1
4-PS4-2
4-PS4-3

Earth and Space Sciences
4-ESS3-1

Engineering, Technology, and Applications of Science
3–5-ETS1-1; 3–5-ETS1-2; 3–5-ETS1-3

NOTE

The three modules for grade 4 in FOSS Pathways are:

- Energy
- Soils, Rocks, and Landforms
- Senses and Survival

Module Matrix
At a Glance

Phenomenon and Storyline	Driving Question and Focus Questions	Content and Disciplinary Core Ideas	Practices and Crosscutting Concepts	NGSS PEs
INV. 1 Energy and Circuits **Phenomenon 1—Solar lights working and not working:** There are 10 solar lights along a pathway in a park. At night, seven of the lights turn on to light the path. Three of the solar lights do not turn on. **Storyline:** Students observe firsthand the phenomenon of a bulb lighting up when they connect wires and a D-cell in a certain way. They figure out that energy can be transferred from place to place by electric currents. They design circuits using D-cells, solar cells, wires, lightbulbs, switches, and motors in different configurations to transfer energy. They record and organize data using appropriate tools for the task, constructing reasonable explanations, and engaging in the engineering design process. They begin to collect evidence that whenever there is motion, electric current, sound, light, and/or heat, there is energy. Students experience the crosscutting concept of energy and matter—energy can be transferred in various ways.	***What could cause some of the lights to shine but not others?*** **FOCUS QUESTIONS:** **What is needed to light a bulb?** **What materials transfer electricity?** **How can you transfer energy using solar cells?**	**PS3.A:** Definitions of energy **PS3.B:** Conservation of energy and energy transfer **PS3.D:** Energy in chemical processes and everyday life **ESS3.A:** Natural resources • An electric circuit is a system that includes a complete pathway through which electric current flows. • Electricity transfers energy that can produce heat, light, sound, and motion. Electricity can be produced from a variety of sources. • A change, such as producing light or motion, is evidence of the presence of energy (energy transfer). • Conductors are materials through which electric current can flow; all metals are conductors. • The energy of two energy sources (D-cells or solar cells) combines when they are wired in series, delivering more power than a single source. • Humans impact the environment by using natural resources to produce energy. Some resources are renewable; others are not.	**Science and Engineering Practices** Asking questions and defining problems Planning and carrying out investigations Analyzing and interpreting data Constructing explanations and designing solutions Obtaining, evaluating, and communicating information **Crosscutting Concepts** Cause and effect Systems and system models Energy and matter	**4-PS3-2:** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. **4-PS3-4:** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. **4-ESS3-1:** Obtain and combine information that energy and fuels are derived from natural resources and that their uses affect the environment. **3–5 ETS1-1:** Define a simple design problem.
INV. 2 Information Transfer Systems **Phenomenon 2—Sending and receiving text messages:** A student is in a park with a friend. Suddenly their phone dings and they read the incoming message from a relative. They pack up and head to the arranged meeting place. **Storyline:** Investigation 2 introduces experiences that suggest a relationship between electricity and magnetism. Students find that when an electric current flows through a coil of wire wrapped around an iron core, the iron core produces magnetism. Their concept of an electromagnet develops. Electromagnets can transfer energy to produce motion, sound, light, or heat. Electromagnets can be used to transfer information. Students design and construct a telegraph to apply scientific ideas to test and refine a device that transfers information and energy via coding patterns. They compare different technologies that use different energy and coding systems.	***How does a message get from a sender to a receiver on a cell phone?*** **FOCUS QUESTIONS:** **How can you turn a steel rivet into a magnet that turns on and off?** **How can you reinvent the telegraph using your knowledge of energy and electromagnetism?** **How do different information transfer systems compare?**	**PS3.A:** Definitions of energy **PS3.B:** Conservation of energy and energy transfer **PS3.D:** Energy in chemical processes and everyday life **PS4.C:** Information technologies and instrumentation **ETS1.A, 1.B, and 1.C** • A magnetic field surrounds a wire through which electric current is flowing and can induce magnetism in iron. • An electromagnet is made by sending electric current through an insulated wire wrapped around an iron core. • The amount of electric current flowing in an electromagnet circuit affects the strength of the magnetism in the core. • A telegraph system is an electromagnet-based technology used for long-distance communication. • Energy is present when there are moving objects or sound. • Different systems have been engineered to code and decode messages using electricity, light, magnetic fields, and radio waves.	**Science and Engineering Practices** Developing and using models Planning and carrying out investigations Analyzing and interpreting data Using mathematics and computational thinking Constructing explanations and designing solutions Obtaining, evaluating, and communicating information **Crosscutting Concepts** Patterns Cause and effect Systems and system models Energy and matter	**4-PS3-2:** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. **4-PS3-4:** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. **4-PS4-3:** Generate and compare multiple solutions that use patterns to transfer information. **ETS1-1, 1-2, 1-3**

Module Matrix
At a Glance CONTINUED

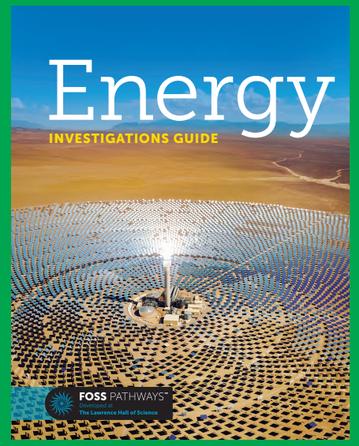
Phenomenon and Storyline	Driving Question and Focus Questions	Content and Disciplinary Core Ideas	Practices and Crosscutting Concepts	NGSS PEs
INV. 3 Energy Transfer **Phenomenon 3—Knocking down bowling pins:** Two children are bowling. The older one uses a 12-pound ball and rolls the ball very quickly toward the 10 pins. The ball knocks down all the pins. The younger child uses an 8-pound ball and rolls the ball slowly down the alley. Even though both balls were aimed the same, the 8-pound ball only knocks down some of the pins. **Storyline:** Investigation 3 introduces experiences that develop a relationship between the mass and the speed of rolling objects. Students plan and carry out investigations with steel balls and ramps to collect and analyze data about mass, starting position, speed, and energy transfer. The potential energy due to the position of a ball on a ramp is easily transformed into kinetic energy of motion as gravity pulls the ball down the slope. Students analyze the data to determine the patterns and cause-and-effect relationships. They then construct explanations based on evidence about the different amounts of energy transfer in bowling or other collisions. Students use patterns of change between two interacting objects to make predictions about the transfer of energy (cause and effect). They use ball-and-ramp systems to serve as models to demonstrate energy transfer from moving objects to stationary objects (energy and matter).	***What causes the two bowling balls to knock down different numbers of pins?*** **FOCUS QUESTIONS:** **How does the starting position affect the speed of a ball rolling down a ramp?** **What happens when objects collide?**	**PS3.A:** Definitions of energy **PS3.B:** Conservation of energy and energy transfer **PS3.C:** Relationship between energy and forces • Energy is evident whenever there is motion. Energy can be transferred from place to place. • Kinetic energy is energy of motion; potential energy is energy of position or condition. • Objects at higher positions have more potential energy. • The faster an object is moving, the more kinetic energy it has. • When objects collide, energy can transfer between objects, thereby changing their motion. • When two objects interact, each one exerts a force on the other, and these forces can transfer energy.	**Science and Engineering Practices** Asking questions Planning and carrying out investigations Analyzing and interpreting data Using mathematics and computational thinking Constructing explanations Obtaining, evaluating, and communicating information **Crosscutting Concepts** Patterns Cause and effect Systems and system models Energy and matter	**4-PS3-1:** Use evidence to construct an explanation relating the speed of an object to the energy of that object. **4-PS3-3:** Ask questions and predict outcomes about the changes in energy that occur when objects collide.
INV. 4 Light and Waves **Phenomenon 4—Unable to see during power outage:** During a storm at night, the power goes out. All lights are off and we cannot see anything in the room. When we turn on a flashlight, we can see those objects that are in the beam of light. **Phenomenon 5—Moving up and down:** Two students are standing apart from each other on the playground, each holding one end of a long jump rope. The first student moves their arm up and down and puts the rope in motion, moving up and down. The second student is holding on to the rope tightly and feels their hand and arm moving up and down too. **Storyline:** Investigation 4 provides students with experiences using light waves (electromagnetic waves) and water and sound waves (mechanical waves). Students integrate firsthand experiences with information obtained from media to construct explanations and develop models. Students use patterns, cause and effect, and systems and system models to add to their understanding of energy and matter.	***Why can we see objects when we use the flashlight, but not when the room is absolutely dark?*** ***What causes the second student's hand to move up and down?*** **FOCUS QUESTIONS:** **What causes objects to be seen?** **How do waves transfer energy to objects?**	**PS4.B:** Electromagnetic radiation **PS4.A:** Wave properties • Light travels in a straight line and can reflect (bounce) off surfaces. • An object is seen only when light from that object enters and is detected by the eye. • Waves are a repeating pattern of motion that transfer energy from place to place. • There are electromagnetic waves (light waves, radio waves) and mechanical waves (ocean waves and sound waves). • Some electromagnetic waves can be detected by humans (light); others can be detected by designed technologies (radio waves). • Waves have properties—amplitude, wavelength, and frequency.	**Science and Engineering Practices** Developing and using models Planning and carrying out investigations Analyzing and interpreting data Using mathematics and computational thinking Constructing explanations Engaging in argument from evidence Obtaining, evaluating, and communicating information **Crosscutting Concepts** Patterns Cause and effect Systems and system models Energy and matter	**4-PS4-1:** Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. **4-PS4-2:** Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

FOSS Pathways includes:

Investigations Guide

The Investigations Guide is a spiral-bound guide containing everything you need to teach the module. FOSS active investigation lesson plans include:

- Three-dimensional learning objectives
- Relevant and local phenomena storylines with driving questions
- Sense-making discussions
- Embedded assessment and “What to Look For” guidance
- Vocabulary reviews
- English language support strategies
- ELA strategies and connections

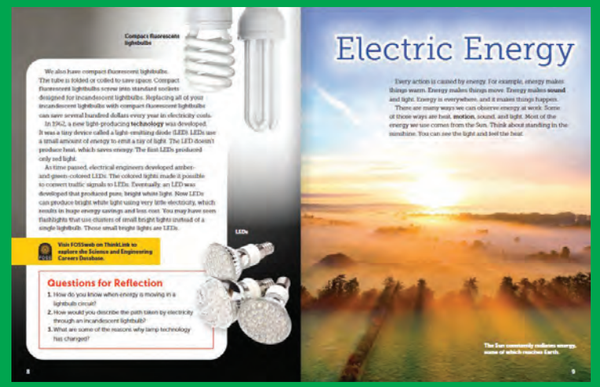


Science Resources Student Book

The *FOSS Science Resources* student book contains readings developed to reinforce, extend, or apply core ideas covered during FOSS active investigations. Readings give students opportunities to:

- Use text to obtain, evaluate, and communicate information
- Use evidence to support their ideas during sense-making discussions and focus question responses
- Integrate information from multiple sources
- Interpret graphs, diagrams, and photographs to build understanding

Available in print and as an interactive eBook in English and Spanish.



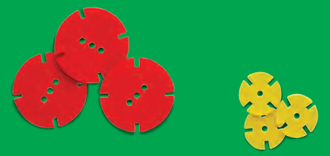
▶ Images on this page include actual components, resources and/or materials provided in FOSS kits.

Equipment Kit

FOSS provides the equipment needed for all the investigations, including metric measuring tools. Our high-quality, classroom-tested materials are long-lasting and packaged by investigation to facilitate preparation and clean up. There is enough permanent equipment in each kit for 32 students. Consumable materials are supplied for three uses. Convenient grade-level and refill kits are available.

Technology

Online resources include duplication masters, eInvestigations Guide, teaching slides, FOSSmap online assessment, streaming videos, virtual investigations, and tutorials, as well as a library of teacher resources, including access and equity, three-dimensional teaching and learning, and environmental literacy.



SCAN HERE FOR A TOUR OF FOSSWEB!

FOSSweb on ThinkLink

FOSSweb digital resources are delivered on School Specialty's curriculum platform called ThinkLink.

- Supports single sign-on and class management with Google classroom and learning management systems.
- Provides access to both teacher and student digital resources, including duplication masters, teaching slides, FOSSmap online assessment, streaming videos, and online activities.

Teaching Slides

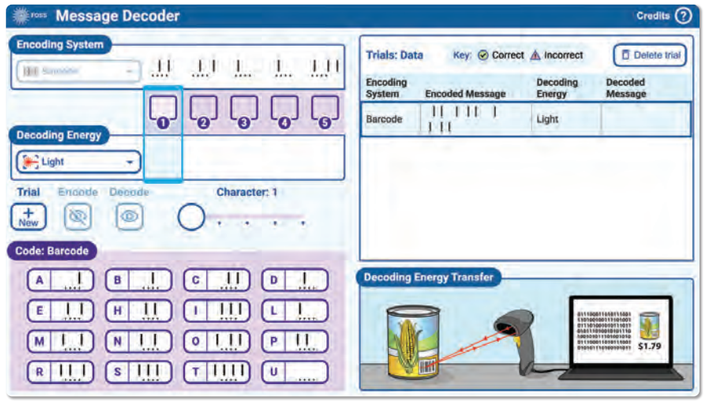
Downloadable and editable slides from FOSSweb can be used to facilitate each part of each investigation. Teaching slides are available as Google slides in English and Spanish.

Streaming Videos

New engaging content videos in English and Spanish were developed to specifically support FOSS investigations.

Online Activities

New engaging simulations developed to address core ideas in FOSS, and interactive virtual investigations and tutorials offer additional content support for students.



Interactive eBooks

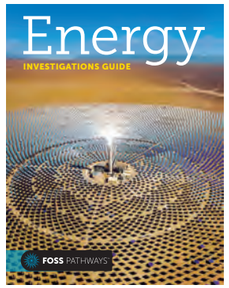
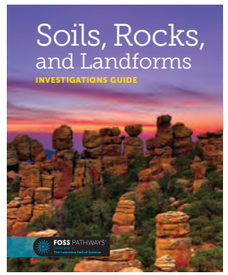
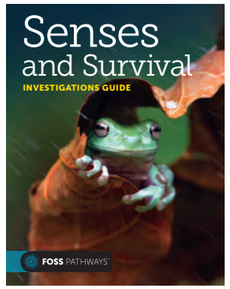
Keep your students engaged while teaching literacy skills with interactive *FOSS Science Resources* eBooks. The eBooks include integrated audio with text syncing and links to online activities and videos that bring the photos to life.

FOSSmap Online Assessment

Students in grades 3–5 can take summative assessments online with automatic coding of most responses. Student- and class-level reports help you identify the need for instructional next steps.

Grade Level Planning Guide

FOSS Pathways Modules Grade 4

FOSS Module	Module Overview/Bundled Performance Expectations	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts
 Physical Science	In the Energy Module, students investigate electricity and magnetism as related effects and engage in engineering design to convert energy from one form to another. They gather information about how energy is derived from natural resources and how that affects the environment and explore alternative sources of energy such as solar energy. Students interpret data to build explanations from evidence and make predictions of future events. They develop models to represent how energy moves from place to place in electric circuits and in waves. **NGSS PEs:** **Physical Sciences:** **4-PS3-1 4-PS4-1** **4-PS3-2 4-PS4-2** **4-PS3-3 4-PS4-3** **4-PS3-4** **Earth and Space Sciences:** **4-ESS3-1** **ETAS:** **3-5-ETS1-1** **3-5-ETS1-2** **3-5-ETS1-3**	**PS3.A:** Definitions of energy **PS3.B:** Conservation of energy and energy transfer **PS3.C:** Relationship between energy and forces **PS3.D:** Energy in chemical processes and everyday life **PS4.A:** Wave properties **PS4.B:** Electromagnetic radiation **PS4.C:** Information technologies and instrumentation **ESS3.A:** Natural resources **ETS1.A:** Defining and Delimiting Engineering Problems **ETS1.B:** Developing Possible Solutions **ETS1.C:** Optimizing The Design Solution	• 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	• Patterns • Cause and effect • Systems and system models • Energy and matter
 Earth Science	In the Soils, Rocks, and Landforms module, students plan and carry out investigations by incrementally changing specific environmental conditions to determine the impact of changing the variables of slope and amount of water in stream tables. Students analyze and interpret data from diagrams and visual representations to build explanations from evidence and make predictions of future events. They develop model mountains and represent the landforms from different perspectives to look for change. Students gain experiences that will contribute to understanding of the crosscutting concepts of patterns; cause and effect; scale, proportion, and quantity; systems and system models; and stability and change. **NGSS PEs:** **Earth and Space Sciences:** **4-ESS1-1** **4-ESS2-1** **4-ESS2-2** **4-ESS3-2** **ETAS:** **3-5-ETS1-2**	**ESS1.C:** History of planet Earth **E:SS2.A:** Earth materials and systems **ESS2.B:** Plate tectonics and large-scale system interactions **ESS2.E:** Biogeology **ESS3.B:** Natural hazards **ETS1.B:** Developing possible solutions	• 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	• Patterns • Cause and effect • Scale, proportion, and quantity • Systems and system models • Stability and change • Energy and matter
 Life Science	In the Senses and Survival Module, students plan and carry out investigations with stimulus and response to gather data to develop models and construct explanations. Students design physical models to understand how structures in a system function together to provide information and resources to organisms to support survival. Students gain experiences that will contribute to the understanding of these crosscutting concepts: cause and effect; systems and system models; and structure and function. **NGSS PEs:** **Life Sciences:** **4-LS1-1** **4-LS1-2** **ETAS:** **3–5-ETS1-1**	**LS1.A:** Structure and function **LS1.D:** Information processing	• Asking questions • Developing and using models • Planning and carrying out investigations • Analyzing and interpreting data • Using mathematics and computational thinking • Constructing explanations • Engaging in argument from evidence • Obtaining, evaluating, and communicating information	• Cause and effect • Systems and system models • Structure and function

FOSS® Pathways™ is an engaging PreK–5 science program developed at the Lawrence Hall of Science for the Next Generation Science Standards (NGSS). This sampler will introduce you to the major components of the program and show examples from FOSS Pathways Energy Investigations Guide.

Recommended Scope and Sequence

FOSS Pathways

GRADE	PHYSICAL SCIENCE	EARTH SCIENCE	LIFE SCIENCE
PK		Observing Nature	
K	Materials and Forces	Trees and Weather	Animals Two by Two
1	Sound and Light	Changes in the Sky	Plants and Animals
2	Solids and Liquids	Water and Landforms	Insects and Plants
3	Motion	Water and Climate	Structures of Life
4	Energy	Soils, Rocks, and Landforms	Senses and Survival
5	Mixtures and Solutions	Earth and Sun	Living Systems

Learn more at **FOSSPathways.com**

Scan the QR code and explore additional FOSS Pathways Samplers today.

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