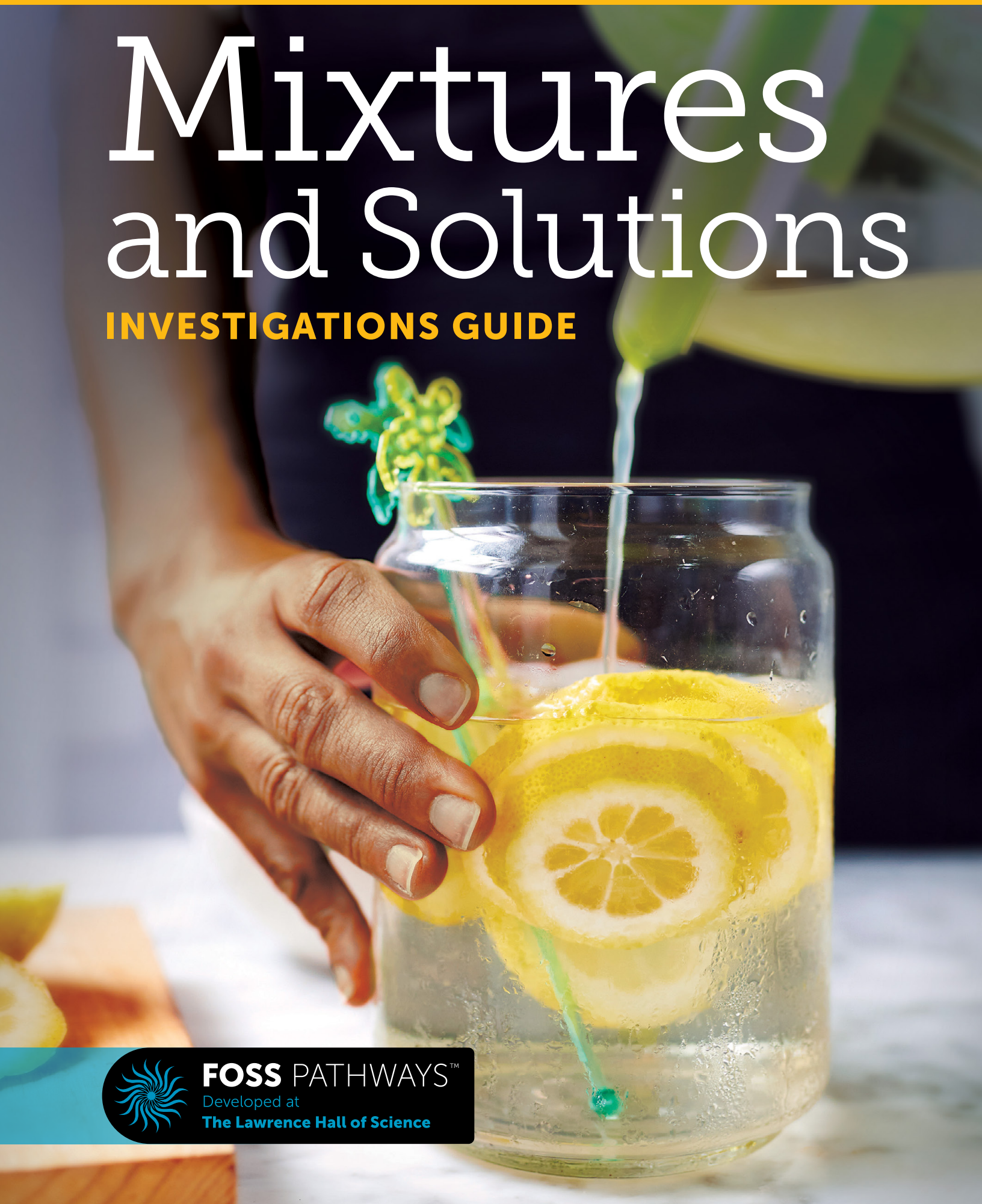
SAMPLER

Mixtures and Solutions

INVESTIGATIONS GUIDE



FOSS PATHWAYS™
Developed at
The Lawrence Hall of Science

PreK–5 science that meets the challenge of our time

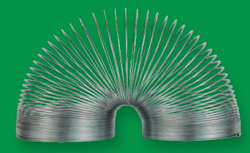
Welcome to new FOSS Pathways. Now as never before, the world needs scientific thinkers—to view the world thoughtfully, approach challenges analytically, and embrace opportunities enthusiastically. For educators to help unlock this potential in their students, they need powerful tools that work for the 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

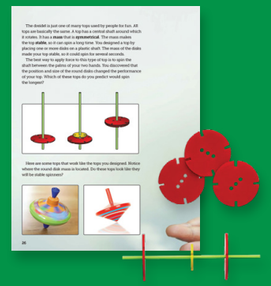
The Full Option Science System™ (FOSS) was conceived to enlist students not as passive recipients of information, but as active investigators of phenomena. That principle has proven its worth for 150,000 teachers and 4 million students across all 50 states, building a legacy of student engagement and 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



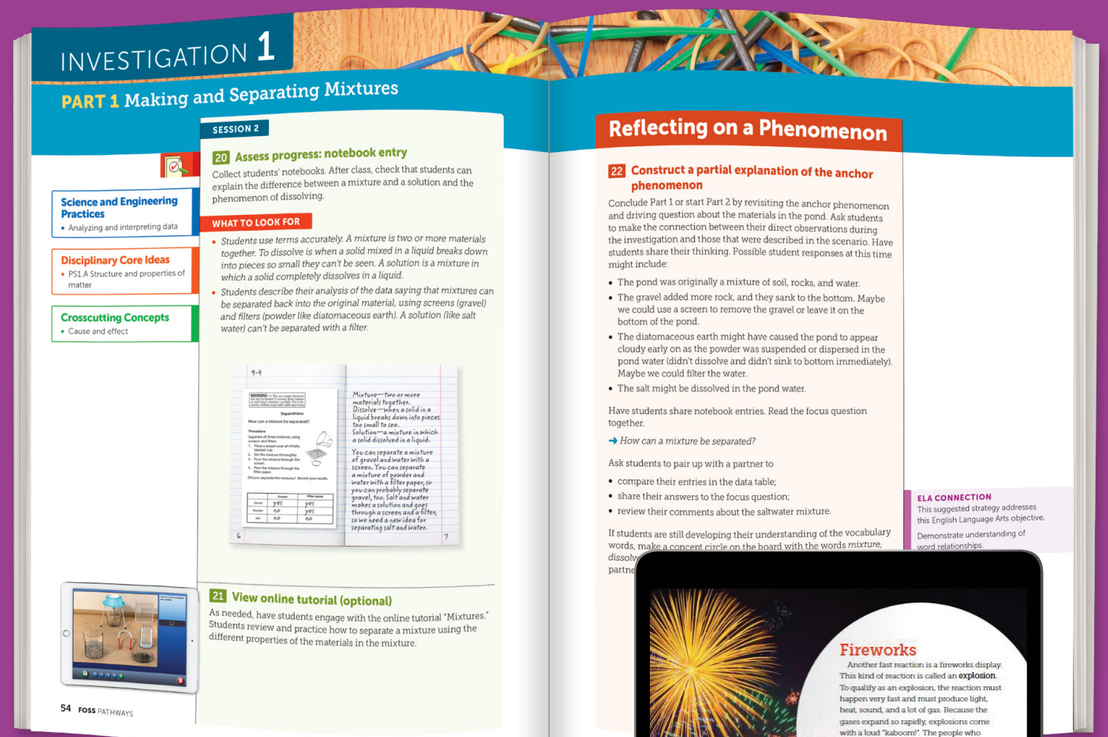
Teaches through a multimodal approach to resonate with every student

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

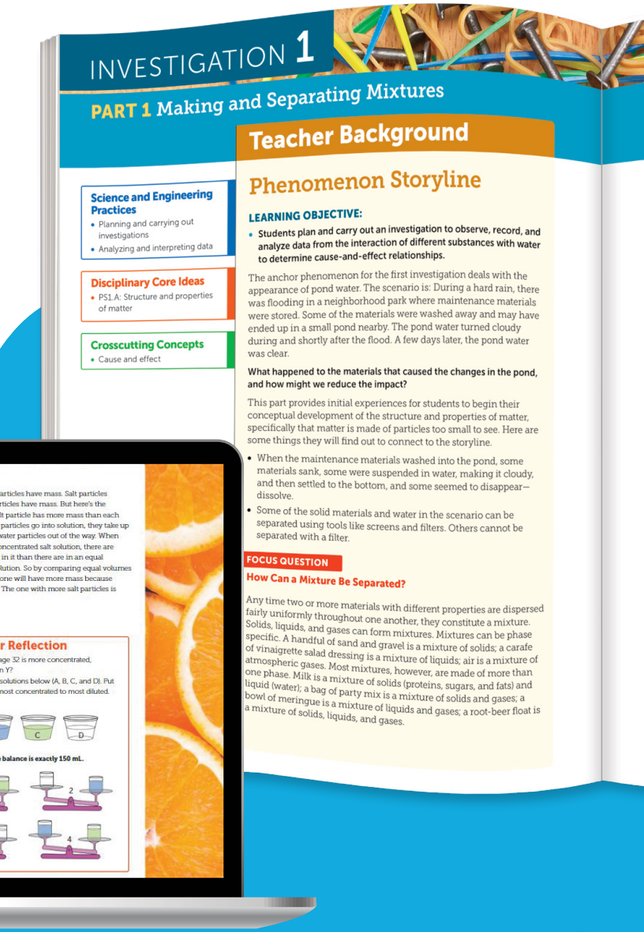
Research-based and field-tested assessments accurately measure student learning and progress. A variety of formative assessment tools provide evidence of students' use of the three dimensions and their knowledge of phenomena.

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

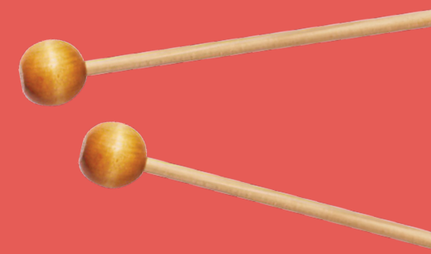
Clear integration of ELA/ELD skills and practices, with ties to standards and resources for engaging multilingual students

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 5 NGSS Performance Expectations	FOSS Mixtures and Solutions	
	Investigation(s)	Benchmark Assessment
5-PS1-1: Develop a model to describe that matter is made of particles too small to be seen.	**Investigation 1** **Investigation 2**	• Investigation 1 I-Check • Investigation 2-3 I-Check • Survey/Posttest
5-PS1-2: Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.	**Investigation 1** **Investigation 2**	• Investigation 1 I-Check • Investigation 2-3 I-Check • Survey/Posttest
5-PS1-3: Make observations and measurements to identify materials based on their properties.	**Investigation 3**	• Investigation 2-3 I-Check • Survey/Posttest
5-PS1-4: Conduct an investigation to determine whether the mixing of two or more substances results in new substances.	**Investigation 5**	• Survey/Posttest
5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.	**Investigation 2** **Investigation 3**	• Investigation 3 • 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 4**	• Investigation 4 • 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**	• Investigation 2-3 I-Check



Mixtures and Solutions Investigations

Investigation 1: Separating Mixtures

Part 1: Making and Separating Mixtures
Part 2: Separating a Salt Solution
Part 3: Separating a Pond-Water Mixture
Part 4: Comparing Melting and Dissolving

Investigation 2: Concentration Models

Part 1: Salt Concentration
Part 2: Applying Concentration to Solve Problems

Investigation 3: Properties of Matter

Part 1: Reaching Saturation
Part 2: Solubility Puzzle
Part 3: Properties and Use of Metals

Investigation 4: Chemical Interactions

Part 1: Chemical Reactions
Part 2: Reaction Products

FOSS

Mixtures and Solutions

Start here to begin your review of the Grade 5 Mixtures and Solutions Investigations Guide

Introduction

The **Mixtures and Solutions Module** has four investigations that engage students with the phenomena of matter and its interactions in our everyday life—mixtures, solutions, solubility, concentration, and chemical reactions. Three anchor phenomena drive the investigations.

- Anchor phenomenon 1—change in pond water/impact of salt on pond life
- Anchor phenomenon 2—identifying unknown substances
- Anchor phenomenon 3—baking soda interactions

Students construct models about matter made of particles too small to be seen and develop the understanding that matter is conserved when it changes state (from solid to liquid), when it dissolves in another substance, and when it is part of a chemical reaction. Students have experiences with mixtures, solutions of different concentrations, and reactions forming new substances. They also engage in engineering experiences using the properties of materials to design useful products. Learning about the properties and behaviors of substances and systems of substances develops their understanding about how things go together and how they can be taken apart. This gives them the opportunity to use and develop models that explain phenomena too small to see directly. Students gain experiences that will contribute to the understanding of the crosscutting concepts of patterns; cause and effect; scale, proportion, and quantity; systems and system models; and energy and matter.

CONTENTS

The NGSS Performance Expectations bundled in this module include:

Physical Sciences
5-PS1-1
5-PS1-2
5-PS1-3
5-PS1-4

Earth and Space Sciences
5-ESS3-1

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

NOTE

The three modules for grade 5 in FOSS Pathways are:

- Mixtures and Solutions
- Earth and Sun
- Living Systems

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 Separating Mixtures **Phenomenon 1—Change in pond water:** During a hard rain, there was flooding in a neighborhood park where maintenance materials were stored. Some of the materials were washed away and may have ended up in a small pond nearby. The pond water turned cloudy during and shortly after the flood. A few days later, the pond water was clear. **Storyline:** Students engage with three distinct phenomena: simple mixtures, suspensions, and solutions. They make mixtures of water and solid materials and separate the mixtures with screens and filters. They find that water and salt make a particular kind of mixture, a solution, which cannot be separated with a filter but only through evaporation. They begin to develop a model of dissolving. Students are challenged with a problem: how to separate a pond water mixture. The investigation concludes with students applying their understanding of dissolving to another process, melting.	***What happened to the materials that caused the changes in the pond, and how might we reduce their impact?*** **FOCUS QUESTIONS:** **How can a mixture be separated?** **Where does the solid material go when a solution is made?** **How can you separate a pond-water mixture?** **What is the difference between melting and dissolving?**	**PS1.A:** Structure and properties of matter • A mixture is two or more materials intermingled. • An aqueous solution is a mixture in which a substance dissolves in water to make a clear liquid. • Mixtures can be separated into their constituents. • The mass of a mixture is equal to the mass of its constituents. • When solid substances dissolve, they break up into particles too small to see. • Mixtures and solutions can be separated using screens, filters, and evaporation. • Possible solutions to a problem are limited by available materials and resources (constraints). • Melting is a change in a single substance from solid to liquid caused by heat (energy transfer). • Dissolving is an interaction between two (or more) substances (solute and solvent). • The amount of matter is conserved when it changes form.	**Science and Engineering Practices** Asking questions 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 **Crosscutting Concepts** Cause and effect Scale, proportion, and quantity Systems and system models Energy and matter	**5-PS1-1:** Develop a model to describe that matter is made of particles too small to be seen. **5-PS1-2:** Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. **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.
INV. 2 Concentration Models **Problem—Impact of salt on pond life:** In anchor phenomenon 1, students investigated the results of salt dissolving in a freshwater pond. In this investigation, students revisit the scenario. They develop a way to describe the concentration of salt in the pond in order to predict the impact to pond organisms. **Storyline:** Concentration is an important phenomenon impacting many of the natural and designed systems in students' lives—from chemicals in water to carbon dioxide or other gases in the air. Students observe and compare soft-drink solutions that differ in the amount of powder (water held constant) and in the amount of water (powder held constant) in order to develop the concept of concentration. They make salt solutions of different concentrations and determine the relative concentrations by comparing the mass of equal volumes of the solutions. They use the same strategy to determine the salinity of two pond samples and compare them to a standard to determine safety for pond life. Students expand their understanding to gas solutions and obtain information about the climate change indicator of concentration of carbon dioxide in the air.	***How can solutions made with the same substances be distinguished from one another, and how will this help us determine the impact of salt pollution in a pond?*** **FOCUS QUESTIONS:** **How can you determine which salt solution is more concentrated?** **How does concentration help to explain climate change?**	**PS1.A:** Structure and properties of matter • Concentration is the amount of dissolved solid material per unit volume of water. • Solutions with a lot of solid dissolved in a volume of water are concentrated; solutions with little solid dissolved in a volume of water are dilute. • A concentrated solution can be diluted with water. • When equal volumes of two salt solutions are weighed, the heavier one is the more concentrated solution. • Matter can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. • Air is a solution of gases (21% oxygen, 78% nitrogen, and a few other gases, including carbon dioxide). • The average concentration of global carbon dioxide shows a trend of increasing carbon dioxide concentration in Earth's atmosphere (The Keeling Curve).	**Science and Engineering Practices** Asking questions Developing and using models Planning and carrying out investigations Analyzing and interpreting data Using mathematics and computational thinking Constructing explanations Obtaining, evaluating, and communicating information **Crosscutting Concepts** Cause and effect Scale, proportion, and quantity	**5-PS1-1:** Develop a model to describe that matter is made of particles too small to be seen. **5-ESS3-1.** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

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 Properties of Matter **Phenomenon 2—Identifying unknown substances:** A teacher finds three jars containing white substances inside the supply closet. The teacher wants to create labels for the jars with the names of the substance and asks you to help figure out what is inside each jar. **Storyline:** Students investigate the solubility of solutes in water to discover that there is a different maximum amount of every solute that will dissolve in a measure of water—the phenomenon of saturation. Students make a saturated solution by adding salt to water until no more salt will dissolve. They also make a saturated Epsom salts solution. Using a balance, they compare the solubility of the two solid materials by comparing the mass of the salt and Epsom salts dissolved in the saturated solutions. Students use the property of solubility to identify an unknown material. They use an online activity to find out about major properties of metals and use that understanding to select the best material to use in designing common objects.	***What observations and measurements of a substance's properties will help to identify what it is?*** **FOCUS QUESTIONS:** **How can the amount of a substance that will dissolve in 50 mL of water help to identify the substance?** **What is the identity of each of the three unknown substances?** **What properties of metals are useful when designing products?**	**PS1.A:** Structure and properties of matter **ESS3.C:** Human impacts on Earth systems **ETS1.B:** Designing solutions to engineering problems • A solution is saturated when as much solid material as possible has dissolved in the liquid. • Solubility is the property that indicates how readily a solute dissolves in a solvent. • A substance is a single, pure material. • Solubility varies from substance to substance and is affected by the kind of solvent, temperature, and other factors. • The property of solubility in water can be helpful to identify an unknown substance. • Evaporation of solutions results in solid crystals to help identify the solute. • Thermal conductivity is how well a material transfers heat; electrical conductivity is how well a material transfers electricity. • The differences in structure and properties of matter are useful in selecting materials, such as metals, to design products.	**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 Scale, proportion, and quantity Systems and system models Energy and matter Structure and function	**5-PS1-3:** Make observations and measurements to identify materials based on their properties. **5-ESS3-1:** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. **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.
INV. 4 Chemical Interactions **Phenomenon 3—Baking soda interactions:** An adult has a stomachache due to indigestion, so they drink a mixture of baking soda and water as an antacid. After a few minutes they might burp and feel better. Another person uses a recipe to bake a cake, and one of the ingredients is baking soda. **Storyline:** Students make more complex mixtures of water with multiple solutes and observe transformations of reactants to new products—the phenomenon of chemical reaction. Students make three solutions with water, baking soda, citric acid, and calcium chloride. They systematically mix pairs of those solutions and observe the changes that occur. The changes (formation of a gas and a white precipitate) are identified as evidence of a chemical reaction. Students find that sodium bicarbonate reacts with acid to produce a gas, carbon dioxide. This acid could be stomach acid or an ingredient in a cake batter such as citrus juice or buttermilk.	***What is it about baking soda (sodium bicarbonate) that makes it useful as an antacid for stomachaches and for baking cakes?*** **FOCUS QUESTIONS:** **What is the effect of mixing two substances with water?** **How can we identify the products from the baking soda and calcium chloride reaction?**	**PS1.B:** Chemical reactions • Some mixtures of substances result in a chemical reaction. • During reactions, starting substances (reactants) change into new substances (products) with different properties. • Formation of a gas or precipitate is evidence of a chemical reaction. • Some products of a reaction are soluble and can be observed only after evaporating the solution. • Calcium carbonate reacts with acid. • No matter what reaction takes place, the total weight of the substances does not change.	**Science and Engineering Practices** Asking questions Developing and using models Planning and carrying out investigations Analyzing and interpreting data Constructing explanations Obtaining, evaluating, and communicating information **Crosscutting Concepts** Cause and effect Energy and matter	**5-PS1-4:** Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

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:

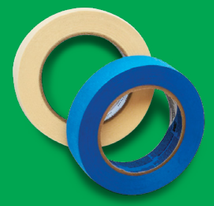
- Use text to obtain, evaluate, and communicate information
- Use evidence to support their ideas during sense-making discussions and focus question responses
- Integrate information from multiple sources
- Interpret graphs, diagrams, and photographs to build understanding

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.

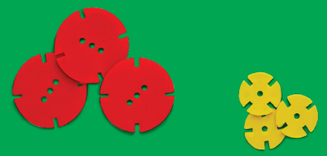
Equipment Kit

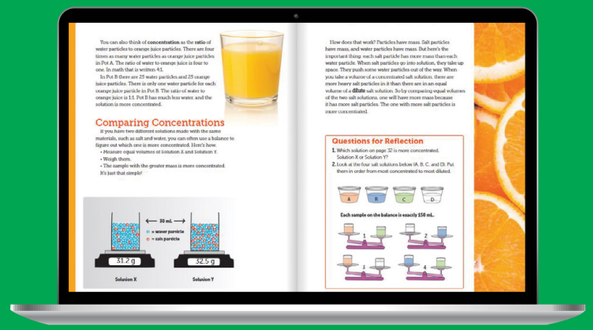
FOSS provides the equipment needed for all the investigations, including metric measuring tools. Our high-quality, classroomtested materials are long-lasting and packaged by investigation to facilitate preparation and clean up. There is enough permanent equipment in each kit for 32 students. Consumable 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!

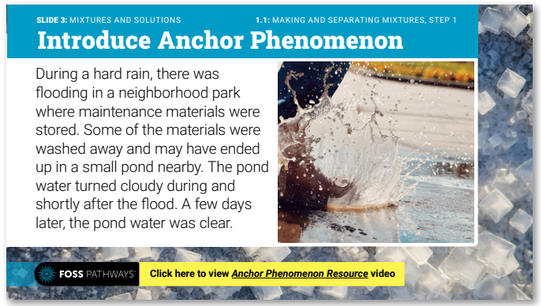
FOSSweb on ThinkLink

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.

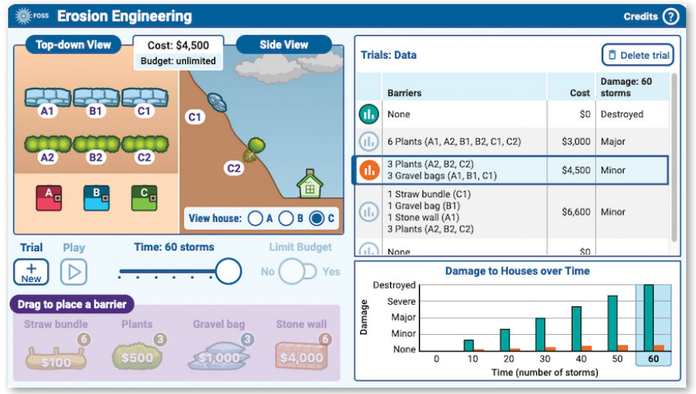


Streaming Videos

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

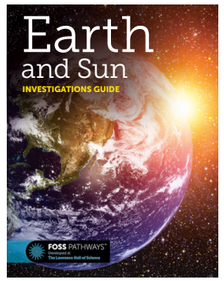
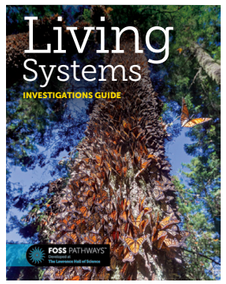
Keep your students engaged while teaching literacy skills with interactive *FOSS Science Resources* eBooks. The eBooks include integrated audio with text syncing and links to online activities and videos that bring the photos to life.

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 5

FOSS Module	Module Overview/Bundled Performance Expectations	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts
 Earth Science	Why do shadows change throughout the day? Why does the sky appear different to people located in different regions of the Earth? Students make observations and reveal patterns of Earth's position in the universe and the motion of the earth, moon, and stars to explain the brightness of stars and patterns of daily, monthly, and yearly changes in the sky. Students develop models of interactions between the atmosphere, hydrosphere, and geosphere and apply the ideas to construct an explanation of why sand is hot and the water cool at a beach on a sunny day. **NGSS PEs:** **Earth Sciences:** **5-ESS1-1** **5-ESS1-2** **5-ESS2-1** **5-ESS2-2** **5-ESS3-1** **Physical Sciences:** **5-PS1-1** **5-PS2-1** **ETAS:** **3-5 ETS1-2** **3-5 ETS1-3**	**ESS1.A:** The universe and its stars **ESS1.B:** Earth and the solar system **ESS2.A:** Earth materials and systems **ESS2.C:** The roles of water in Earth's surface processes **ESS3.C:** Human impacts on Earth systems **PS1.A:** Structure and properties of matter **PS2.B:** Types of interactions **ETS1.A:** Defining and delimiting engineering problems **ETS1.B:** Developing possible solutions **ETS1.C:** Optimizing the design 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 • Energy and matter
 Physical Science	Students investigate changes in a pond in a park and are surprised by the change in appearance to the water. They design and construct investigations to make sense of the particles in mixtures and solutions, and they measure and graph materials to provide evidence for the conservation of matter. Students develop models to describe that matter is made of particles too small to be seen. Finally, they conduct investigations to determine whether the mixing of two or more substances results in new substances. **NGSS PEs:** **Physical Sciences:** **5-PS1-1** **5-PS1-2** **5-PS1-3** **5-PS1-4** **ETAS:** **3-5 ETS1-1** **3-5 ETS1-2** **Earth and Space Sciences:** **5-ESS3-1**	**PS1.A:** Structure and properties of matter **PS1.B:** Chemical reactions **ETS1.A:** Defining and delimiting engineering problems **ETS1.B:** Design solutions to engineering problems **ESS3.C:** Human impacts on Earth systems	• 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 • Energy and matter
 Life Science	Students learn about Dr. Salina Bryan, who has been studying a population of brine shrimp that live in Mono Lake, a large salt lake. Dr. Bryan has noticed that the size of the brine shrimp population and the amount of water in the lake has been decreasing in the last few years. Students design and conduct investigations and analyze data to figure out causes of the decrease in the number of brine shrimp, and the effect on the ecosystem. They explore the flow of matter and energy in ecosystems and develop models to describe how elements of the Earth's major systems support life. **NGSS PEs:** **Life Sciences:** **5-LS1-1** **5-LS2-1** **4-LS1-2 *** **Physical Sciences:** **5-PS3-1** **Earth Sciences:** **5-ESS2-1** **5-ESS3-1** ***This PE is addressed in grade 4 and extended in grade 5**	**LS1.C:** Organization for matter and energy flow in organisms **LS1.D:** Information processing **LS2.A:** Interdependent relationships in ecosystems **LS2.B:** Cycles of matter and energy transfer in ecosystems **PS3.D:** Energy in chemical processes and everyday life **ESS2.A:** Earth materials and systems **ESS3.C:** Human impacts on Earth systems	• 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 • Scale, proportion, and quantity • Systems and system models • Energy and matter • Structure and function • Stability and change

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 Mixtures and Solutions 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**

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UNIVERSITY OF CALIFORNIA, BERKELEY

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