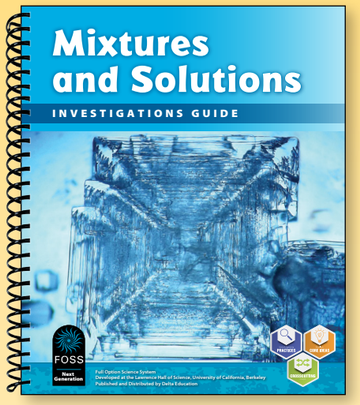
FOSS™

Developed at:

THE LAWRENCE HALL OF SCIENCE™
UNIVERSITY OF CALIFORNIA, BERKELEY

A lifelong fascination with science starts here.

FOSS 6-8 Sampler



FOSS COMPONENTS

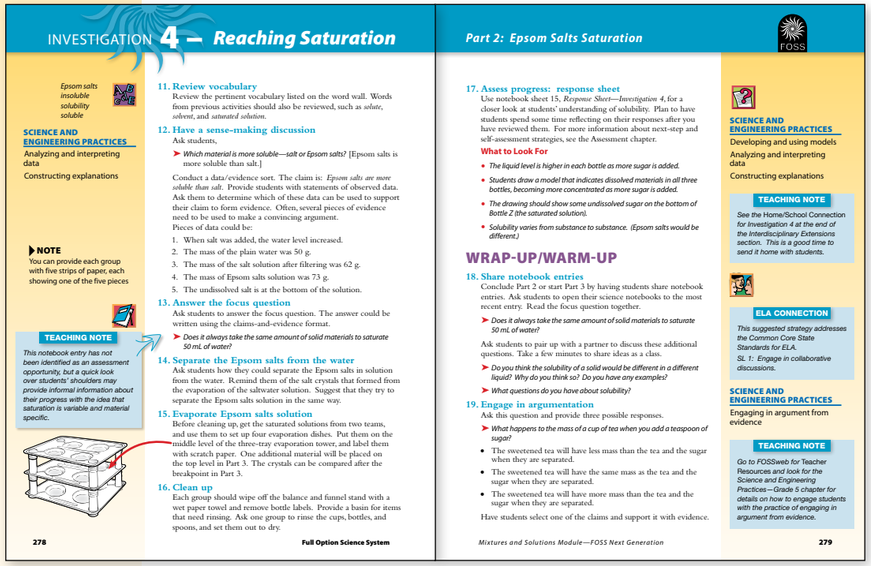
Teacher Toolkit for Each Module

The FOSS Next Generation Program has three modules for grade 5—Mixtures and Solutions, Living Systems, and Earth and Sun.

Each module comes with a *Teacher Toolkit* for that module. The *Teacher Toolkit* is the most important part of the FOSS Program. It is here that all the wisdom and experience contributed by hundreds of educators has been assembled. Everything we know about the content of the module, how to teach the subject, and the resources that will assist the effort are presented here. Each toolkit has three parts.

Investigations Guide. This spiral-bound document contains these chapters.

- Overview
- Framework and NGSS
- Materials
- Technology
- Investigations (five in this module)
- Assessment



INVESTIGATION 4 — *Reaching Saturation*

Epsom salts
insoluble
solubility
soluble

SCIENCE AND ENGINEERING PRACTICES
Analyzing and interpreting data
Constructing explanations

NOTE
You can provide each group with five strips of paper, each showing one of the five pieces

TEACHING NOTE
This notebook entry has not been identified as an assessment opportunity, but a quick look over students' shoulders may provide informal information about their progress with the idea that saturation is variable and material specific.

11. Review vocabulary
Review the pertinent vocabulary listed on the word wall. Words from previous activities should also be reviewed, such as *solute*, *solvent*, and *saturated solution*.

12. Have a sense-making discussion
Ask students,

➤ *Which material is more soluble—salt or Epsom salts?* [Epsom salts is more soluble than salt.]

Conduct a data/evidence sort. The claim is: *Epsom salts are more soluble than salt.* Provide students with statements of observed data. Ask them to determine which of these data can be used to support their claim to form evidence. Often, several pieces of evidence need to be used to make a convincing argument.
Pieces of data could be:

1. When salt was added, the water level increased.
2. The mass of the plain water was 50 g.
3. The mass of the salt solution after filtering was 62 g.
4. The mass of Epsom salts solution was 73 g.
5. The undissolved salt is at the bottom of the solution.

13. Answer the focus question
Ask students to answer the focus question. The answer could be written using the claims-and-evidence format.

➤ *Does it always take the same amount of solid materials to saturate 50 mL of water?*

14. Separate the Epsom salts from the water
Ask students how they could separate the Epsom salts in solution from the water. Remind them of the salt crystals that formed from the evaporation of the saltwater solution. Suggest that they try to separate the Epsom salts solution in the same way.

15. Evaporate Epsom salts solution
Before cleaning up, get the saturated solutions from two teams, and use them to set up four evaporation dishes. Put them on the middle level of the three-tray evaporation tower, and label them with scratch paper. One additional material will be placed on the top level in Part 3. The crystals can be compared after the breakpoint in Part 3.

16. Clean up
Each group should wipe off the balance and funnel stand with a wet paper towel and remove bottle labels. Provide a basin for items that need rinsing. Ask one group to rinse the cups, bottles, and spoons, and set them out to dry.

278 Full Option Science System

Part 2: Epsom Salts Saturation

17. Assess progress: response sheet
Use notebook sheet 15, *Response Sheet—Investigation 4*, for a closer look at students' understanding of solubility. Plan to have students spend some time reflecting on their responses after you have reviewed them. For more information about next-step and self-assessment strategies, see the Assessment chapter.

What to Look For

- *The liquid level is higher in each bottle as more sugar is added.*
- *Students draw a model that indicates dissolved materials in all three bottles, becoming more concentrated as more sugar is added.*
- *The drawing should show some undissolved sugar on the bottom of Bottle Z (the saturated solution).*
- *Solubility varies from substance to substance. (Epsom salts would be different.)*

WRAP-UP/WARM-UP

18. Share notebook entries
Conclude Part 2 or start Part 3 by having students share notebook entries. Ask students to open their science notebooks to the most recent entry. Read the focus question together.

➤ *Does it always take the same amount of solid materials to saturate 50 mL of water?*

Ask students to pair up with a partner to discuss these additional questions. Take a few minutes to share ideas as a class.

➤ *Do you think the solubility of a solid would be different in a different liquid? Why do you think so? Do you have any examples?*

➤ *What questions do you have about solubility?*

19. Engage in argumentation
Ask this question and provide three possible responses.

➤ *What happens to the mass of a cup of tea when you add a teaspoon of sugar?*

- The sweetened tea will have less mass than the tea and the sugar when they are separated.
- The sweetened tea will have the same mass as the tea and the sugar when they are separated.
- The sweetened tea will have more mass than the tea and the sugar when they are separated.

Have students select one of the claims and support it with evidence.

SCIENCE AND ENGINEERING PRACTICES
Developing and using models
Analyzing and interpreting data
Constructing explanations

TEACHING NOTE
See the Home/School Connection for Investigation 4 at the end of the Interdisciplinary Extensions section. This is a good time to send it home with students.

ELA CONNECTION
This suggested strategy addresses the Common Core State Standards for ELA.
SL.1: Engage in collaborative discussions.

SCIENCE AND ENGINEERING PRACTICES
Engaging in argument from evidence

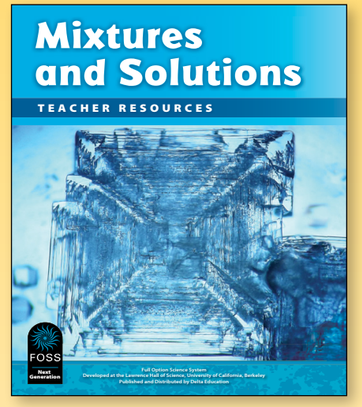
TEACHING NOTE
Go to FOSSweb for Teacher Resources and look for the Science and Engineering Practices—Grade 5 chapter for details on how to engage students with the practice of engaging in argument from evidence.

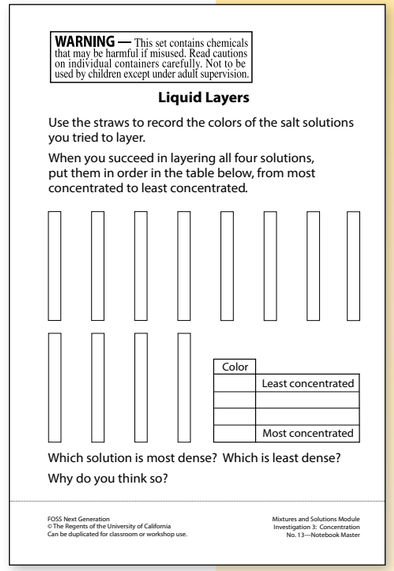
Mixtures and Solutions Module—FOSS Next Generation 279

FOSS Science Resources book. One copy of the student book of readings is included in the *Teacher Toolkit*.

Teacher Resources. These chapters can be downloaded from FOSSweb and are also in the bound *Teacher Resources* book.

- FOSS Program Goals
- Planning Guide—Grade 5
- Science and Engineering Practices—Grade 5
- Crosscutting Concepts—Grade 5
- Sense-Making Discussions for Three-Dimensional Learning—Grade 5
- Access and Equity
- Science Notebooks in Grades 3–5
- Science-Centered Language Development
- FOSS and Common Core ELA—Grade 5
- FOSS and Common Core Math—Grade 5
- Taking FOSS Outdoors
- Science Notebook Masters
- Teacher Masters
- Assessment Masters





WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Liquid Layers

Use the straws to record the colors of the salt solutions you tried to layer.

When you succeed in layering all four solutions, put them in order in the table below, from most concentrated to least concentrated.

Color	
	Least concentrated
	Most concentrated

Which solution is most dense? Which is least dense?

Why do you think so?

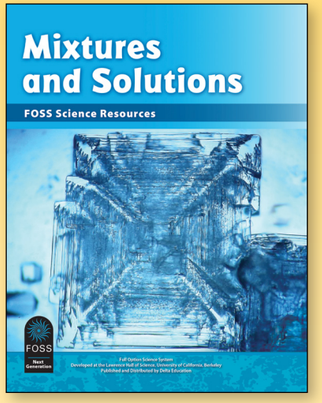
FOSS Next Generation
©The Regents of the University of California
Can be duplicated for classroom or workshop use.

Mixtures and Solutions Module
Investigation 3: Concentration
No. 13—Notebook Master

Equipment for Each Module or Grade Level

The FOSS Program provides the materials needed for the investigations, in sturdy, front-opening drawer-and-sleeve cabinets. Inside, you will find high-quality materials packaged for a class of 32 students. Consumable materials are supplied for three uses before you need to resupply. Teachers may be asked to supply small quantities of common classroom materials.

Delta Education can assist you with materials management strategies for schools, districts, and regional consortia.



FOSS Science Resources Books

FOSS Science Resources: Mixtures and Solutions is a book of original readings developed to accompany this module. The readings are referred to as articles in *Investigations Guide*. Students read the articles in the book as they progress through the module. The articles cover specific concepts, usually after the concepts have been introduced in the active investigation.

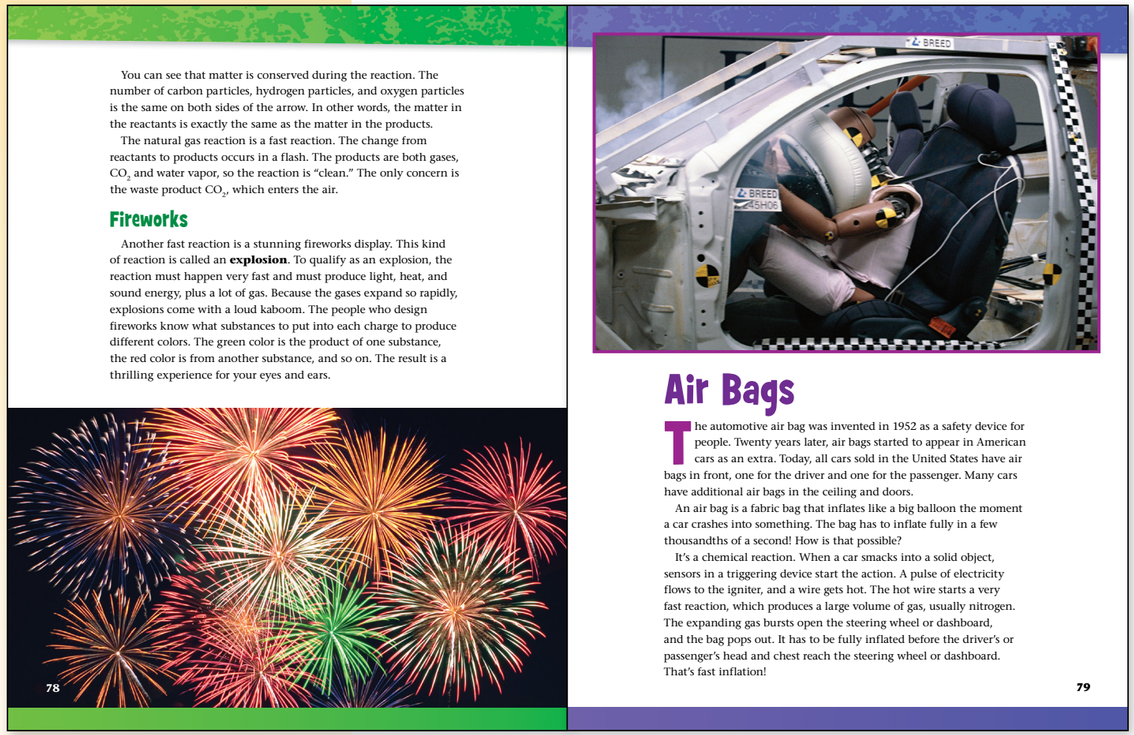
The articles in *FOSS Science Resources* and the discussion questions provided in *Investigations Guide* help students make connections to the science concepts introduced and explored during the active investigations. Concept development is most effective when students are allowed to experience organisms, objects, and phenomena firsthand before engaging the concepts in text. The text and illustrations help make connections between what students experience concretely and the ideas that explain their observations.

Technology

The FOSS website opens new horizons for educators, students, and families, in the classroom or at home. Each module has digital resources for students and families—interactive simulations, virtual investigations, and online activities. For teachers, FOSSweb provides online teacher *Investigations Guides*; grade-level planning guides (with connections to ELA and math); materials management strategies; science teaching and professional development tools; contact information for the FOSS Program developers; and technical support. In addition, FOSSweb provides digital access to PDF versions of the *Teacher Resources* component of the *Teacher Toolkit*, digital-only instructional resources that supplement the print and kit materials, and access to FOSSmap, the online assessment and reporting system for grades 3–8.

With an educator account, you can customize your homepage, set up easy access to the digital components of the modules you teach, and create class pages for your students with access to tutorials and online assessments.

NOTE
To access all the teacher resources and to set up customized pages for using FOSS, log in to FOSSweb through an educator account. See the Technology chapter in this guide for more specifics.


You can see that matter is conserved during the reaction. The number of carbon particles, hydrogen particles, and oxygen particles is the same on both sides of the arrow. In other words, the matter in the reactants is exactly the same as the matter in the products.

The natural gas reaction is a fast reaction. The change from reactants to products occurs in a flash. The products are both gases, CO_2 and water vapor, so the reaction is "clean." The only concern is the waste product CO_2, which enters the air.

Fireworks

Another fast reaction is a stunning fireworks display. This kind of reaction is called an **explosion**. To qualify as an explosion, the reaction must happen very fast and must produce light, heat, and sound energy, plus a lot of gas. Because the gases expand so rapidly, explosions come with a loud kaboom. The people who design fireworks know what substances to put into each charge to produce different colors. The green color is the product of one substance, the red color is from another substance, and so on. The result is a thrilling experience for your eyes and ears.

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Air Bags

The automotive air bag was invented in 1952 as a safety device for people. Twenty years later, air bags started to appear in American cars as an extra. Today, all cars sold in the United States have air bags in front, one for the driver and one for the passenger. Many cars have additional air bags in the ceiling and doors.

An air bag is a fabric bag that inflates like a big balloon the moment a car crashes into something. The bag has to inflate fully in a few thousandths of a second! How is that possible?

It's a chemical reaction. When a car smacks into a solid object, sensors in a triggering device start the action. A pulse of electricity flows to the igniter, and a wire gets hot. The hot wire starts a very fast reaction, which produces a large volume of gas, usually nitrogen. The expanding gas bursts open the steering wheel or dashboard, and the bag pops out. It has to be fully inflated before the driver's or passenger's head and chest reach the steering wheel or dashboard. That's fast inflation!

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Ongoing Professional Learning

The Lawrence Hall of Science and Delta Education strive to develop long-term partnerships with districts and teachers through thoughtful planning, effective implementation, and ongoing teacher support. FOSS has a strong network of consultants who have rich and experienced backgrounds in diverse educational settings using FOSS.

NOTE
Look for professional development opportunities and online teaching resources on www.FOSSweb.com.

FOSS INSTRUCTIONAL DESIGN

FOSS is designed around active investigation that provides engagement with science concepts and science and engineering practices. Surrounding and supporting those firsthand investigations are a wide range of experiences that help build student understanding of core science concepts and deepen scientific habits of mind.

The Elements of the FOSS Instructional Design

Teacher Support

Tools for Effective Teaching

Three-Dimensional Learning Support

Investigation-specific scientific background information for the teacher is presented in each investigation chapter organized by the focus questions. The **Teaching Children about** section makes direct connections to the NGSS for the grade level and are referenced throughout the investigations. For example, see pages 90–95 of your ***FOSS Mixtures and Solutions*** *Investigations Guide.*

Teacher Preparation Video

Teacher Preparation Videos

Videos provide helpful equipment setup instructions, safety information, and a summary of what students will do and learn throughout a part.

Teacher Resource Introductory Videos

Videos provide a general overview of the instructional practices such as making sense of phenomena and sense-making discussions, within FOSS lessons in actual classrooms.

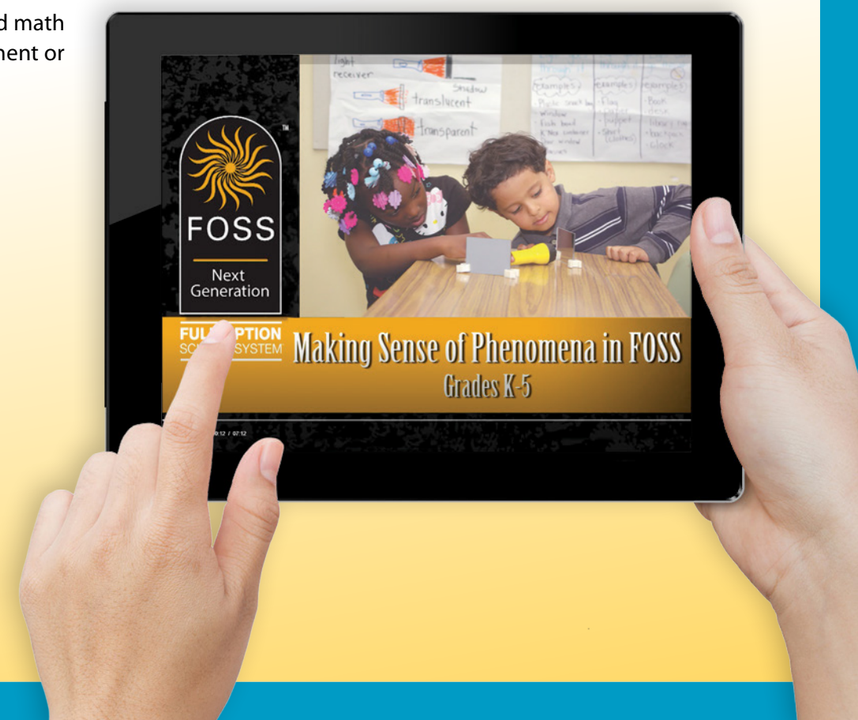
Access and Equity Video

Custom Professional Learning

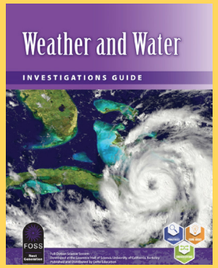
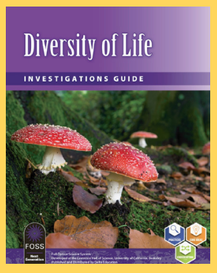
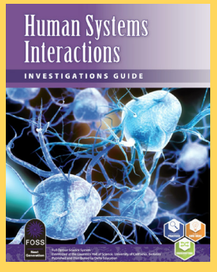
FOSS provides unrivaled teacher support through its strong network of consultants who have rich and experienced backgrounds in diverse educational settings using FOSS.

Home/School Connections

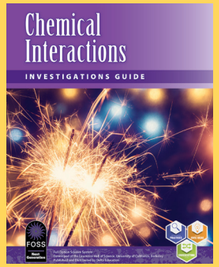
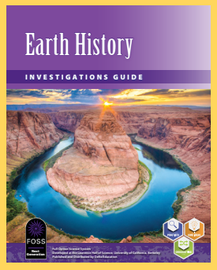
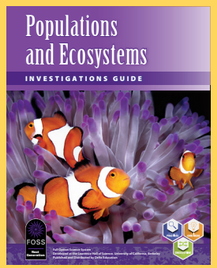
Home-based activities in science and math that can be used for parent involvement or remote learning.



FOSS COURSES—GRADE 6

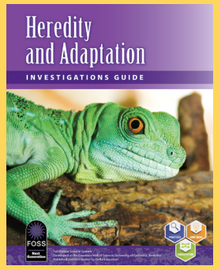
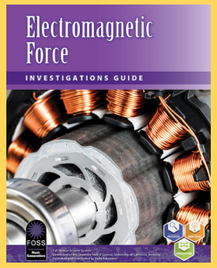
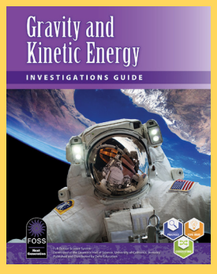
	Course Description	Course Overview	DCIs	Life Science Content	Earth Science Content	Physical Science Content
FOSS Course 1	**FOSS Weather and Water** Students explore physical science processes to explain earth science phenomena. They learn about atoms and molecules, density, wind, and energy transfer then investigate phase change, the water cycle, ocean currents, climate change, and meteorology. 	**Driving question for phenomena:** *What makes weather happen?* **Recommended instructional sequence:** This is a good course to begin the year with, because students explore physical science properties that explain weather and climate phenomena and learn about climate change. This establishes the storyline for grade 6 and sets the groundwork for students to think about interactions between changing environments and organisms' reproductive success.	ESS1.B, ESS2.C, ESS2.D, ESS3.B, ESS3.C, ESS3.D, PS1.A, PS3.A, PS3.B, ETS1.A, ETS1.B, ETS1.C Engineering: • Design criteria • Evaluate solutions • Analyze data • Iteratively test and modify	• Human changes to Earth's environment can have dramatic impacts on different organisms.	• Weather and climate involve interactions among Earth's subsystems. • The movement of water and interacting air masses helps determine local weather patterns and conditions. • Density variations drive global patterns of air and ocean currents. • Water cycles between the land, ocean, and atmosphere. • Burning fossil fuels is a major cause of climate change. Strategic choices can affect the rate of climate change and its impacts.	• Temperature measures the average kinetic energy of the particles that make up matter. • Energy transfers from hot materials to cold materials. • The type and amount of matter affects how much an object's temperature will change.
FOSS Course 2	**FOSS Diversity of Life** Students discover that all living things share the same basic characteristics, that all organisms are composed of cells, and that a single cell is the fundamental unit of life. Students then explore the relationship of organisms to their environment, and explore the concept of biodiversity. 	**Driving question for phenomena:** *How do you know something is living?* **Recommended instructional sequence:** This course creates the foundation for students to think of organisms as made of interacting subsystems. They think about how local conditions affect organisms' growth and reproduction, and consider how changes to climate may affect this reproductive success.	LS1.A, LS1.B, LS1.C, LS2.C, LS3.A, LS3.B	• All living things are made of cells. • The body is a system made of interacting subsystems. • Local conditions affect the growth of organisms. • Variations of inherited traits arise from genetic differences. • Genetic traits and local conditions affect the growth of organisms. • Organisms rely on their body structures and behavior to survive, but these adaptations may not be enough to survive as the climate changes.	• Human farming and land use practices can cause soil to increase in salinity. • Climate change can result in changes to local climate patterns that affect organisms' habitable regions.	• Molecules are the building blocks of cellular structures, and atoms are the building blocks of molecules.
FOSS Course 3	**FOSS Human Systems Interactions** Students tackle big questions about body systems and the factors that affect them. They learn about what happens when the body is attacked by an invader or an organ system malfunctions, how cells get the resources they need to live, and how systems support the human organism as it senses and interacts with the environment. 	**Driving question for phenomena:** *How do humans live, grow, and respond to their environment?* **Recommended instructional sequence:** This course builds on students' developing model of subsystems from Diversity of Life with a focus on understanding the human body. Students explore the complexity of human body system interactions, and then learn about how humans interact with the environment and form complex memories.	LS1.A, LS1.C, LS1.D, PS3.D	• The body is a system made of interacting subsystems. • Food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. • Sensory receptors respond to any array of mechanical, chemical, and electromagnetic stimuli. • Sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.	• Climate change can result in changes to local climate patterns conditions that affect organisms' habitable regions. ***Review the FOSS Grade 6—FOSS Course Foundation Boxes at the end of this chapter for more details about each course.***	• Aerobic cellular respiration is the process by which energy stored in food molecules is converted into usable energy for cells.

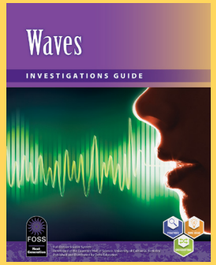
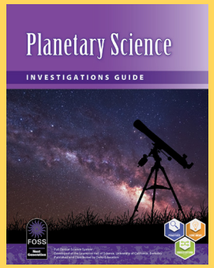
FOSS COURSES—GRADE 7

	Course Description	Course Overview	DCIs	Life Science Content	Earth Science Content	Physical Science Content
FOSS Course 1	**FOSS Chemical Interactions** Students conduct experiments to observe macroscopic matter transformations and apply kinetic particle theory to explain those transformations at the atomic level. They explore conservation of energy and matter and use those principles to explain phase change and chemical reactions. 	**Driving question for phenomena:** *How does matter interact?* **Recommended instructional sequence:** This is a good course to begin the year with, because it provides a foundation for conservation of matter, conservation of energy, and energy transfer that students will draw on as they explore geology and ecosystems in the later courses.	PS1.A, PS1.B, PS3.A, PS3.B, ETS1.A, ETS1.B, ETS1.C Engineering: • Design criteria • Evaluate solutions • Analyze data • Iteratively test and modify	• Food contains many elements essential for life. • Oxygen, carbon, and hydrogen are the most abundant elements in the human body.	• Earth materials are mostly made of eight different elements. • Earth has mineral, energy, and water resources that are unevenly distributed by geoscience processes.	• The interaction and motions of atoms explain the properties of matter. • Thermal energy affects particle motion and phase of matter. • Matter is conserved in physical changes and chemical reactions. • Energy cannot be created or destroyed, only transferred. • Chemical reactions make new substances and can release or absorb thermal energy. • Synthetic materials impact society.
FOSS Course 2	**FOSS Earth History** Students read evidence from rock, landforms, and fossils. They grapple with Earth's processes and systems that have operated over geologic time to understand the cycling of Earth's materials and the flow of energy that drives this process. They consider human interactions with natural resources and the technology that supports the geosciences. 	**Driving question for phenomena:** *How do we tell the geologic story of a place?* **Recommended instructional sequence:** This course builds on the concepts of conservation of matter and energy from Chemical Interactions as students explore geologic processes that define areas on Earth. Students begin to explore human impact on Earth systems, and will build on these ideas when they explore ecosystem dynamics in the next course.	ESS1.C, ESS2.A, ESS2.B, ESS2.C, ESS3.A, ESS3.B, ESS3.C, ESS3.D, LS4.A Engineering: • Evaluate solutions	• Evidence for the existence and diversity of life on Earth, including extinctions, is found in the fossil record. • Design solutions can help maintain biodiversity and ecosystem services.	• Geologic processes change Earth's surface, and rock layers provide a record of Earth's history. • Fossils, rocks, continental shape, and seafloor structures provide evidence of plate motion. • Damage from natural hazards can be reduced. • Rock is constantly being recycled and can be transformed into other rock types. • Earth has mineral, energy, and water resources that are unevenly distributed by geologic processes.	• Uneven heating within Earth explains varying densities of Earth materials that result in convection and plate motion. • Matter is conserved in physical changes and chemical reactions.
FOSS Course 3	**FOSS Populations and Ecosystems** Students learn that every organism has a role to play in its ecosystem. To understand how ecosystems work and what they need to remain healthy, students explore how changes to one part of the ecosystem affect others by studying ecosystem interactions of matter and energy. 	**Driving question for phenomena:** *How do organisms, matter, and energy interact in an ecosystem?* **Recommended instructional sequence:** This course culminates students' grade-level study of energy and matter by asking students to explore interactions in complex ecosystems. Students continue to explore human impact on Earth systems by researching human interactions in a particular ecosystem and providing recommendations for an engineering problem within the ecosystem.	LS1.C, LS2.A, LS2.B, LS2.C, LS4.D, PS3.D, ESS3.C, ETS1.A, ETS1.B Engineering: • Design criteria • Evaluate solutions	• Biotic and abiotic changes affect ecosystem populations. • Matter cycles and energy flows among living and nonliving parts of ecosystems. • Organisms grow and get energy by rearranging atoms in food molecules. • Resource availability affects organisms and ecosystem populations. • Humans depend on ecosystem services. • Design solutions can help maintain biodiversity and ecosystem services.	• Varying climate, terrain, elevation, and latitude define regions known as biomes. • Earth has mineral, energy, and water resources.	• Matter is conserved in physical changes and chemical reactions. • Energy cannot be created or destroyed, only transferred. • Chemical reactions make new substances and can release or absorb thermal energy.

Review the FOSS Grade 7—FOSS Course Foundation Boxes at the end of this chapter for more details about each course.

FOSS COURSES—GRADE 8

	Course Description	Course Overview	DCIs	Life Science Content	Earth Science Content	Physical Science Content
FOSS Course 1	**FOSS Heredity and Adaptation** Students explore evidence for evolution, including the fossil record, the similarities between past and present organisms, the genetic principles of inheritance, and how natural selection produces adaptations that lead to changes in species and eventually the creation of new species. 	**Driving question for phenomena:** *How can we explain the diversity of life that has lived on Earth?* **Recommended instructional sequence:** This is a good course to begin the year with, because students may develop questions about what causes Earth's systems to change dramatically over time (and relatively quickly); this establishes the storyline for grade 8 and sets the groundwork for the capstone project at the end of the year.	LS3.A; LS3.B; LS4.A; LS4.B; LS4.C; ESS1.C	• Mutations in genes affect organisms' structures and functions. • Evidence from fossils, anatomy, and embryos support the theory of biological evolution. • Natural selection is the main mechanism that leads to evolution of species that are adapted to their environment. • Changes to environments can affect probabilities of survival and reproduction of individual organisms, which can result in significant changes to populations and species.	• Rock layers record Earth's history like pages in a book. • The fossil record documents the existence, diversity, extinction, and change of life forms throughout Earth's history. • Earth's environments change over time.	• Predictable chemical properties of matter can be used to interpret the composition and age of rocks.
FOSS Course 2	**FOSS Electromagnetic Force** Students begin to explore the concept of force. They measure the force of invisible magnetic fields, learn to build a circuit, design an electromagnet, and explain the energy transfers that make it all possible. They consider energy sources for human use and limitations of renewable and nonrenewable resources 	**Driving question for phenomena:** *What is the relationship between magnetic and electric forces?* **Recommended instructional sequence:** This course creates the foundation for the physics concepts of force, potential energy, and kinetic energy, which are developed further in Gravity and Kinetic Energy. The idea of human extraction and use of Earth's natural resources provides additional footing for the capstone project, human impact on Earth systems, in Planetary Science.	PS2.A; PS2.B; PS3.A; PS3.B; PS3.C; ESS3.A; ESS3.C; ETS1.A; ETS1.B; ETS1.C Engineering: • Design criteria • Evaluate solutions • Analyze data • Iteratively test and modify		• Energy sources can be categorized as renewable or nonrenewable. • Engineers develop new designs to minimize environmental impact from human energy use.	• Net force is the sum of the forces acting on a mass. • Magnets are surrounded by an invisible magnetic force field, which acts through space. • Electricity and magnetism are observable phenomena stemming from the fundamental force of electromagnetism. • Energy cannot be created or destroyed, only transferred.
FOSS Course 3	**FOSS Gravity and Kinetic Energy** Students explore speed, acceleration, gravity, and collision physics. They explore how the force of gravity is related to the mass of objects and distance between them, and how this relates to gravity on various celestial objects. They learn Newton's laws and engage in an engineering challenge to design a helmet that will provide protection during impact. 	**Driving question for phenomena:** *How can we explain the motion of objects?* **Recommended instructional sequence:** This course builds on students' developing model of force from Electromagnetic Force to understand the stability of orbits, which will be used to explain the Earth/Moon/Sun system and solar system formation in Planetary Science. Students can think back to Heredity and Adaptation to understand how natural selection could result in adaptations in organisms to better sustain the force of collisions.	PS2.A; PS2.B; PS3.A; PS3.B; PS3.C; ESS1.B; ETS1.A; ETS1.B; ETS1.C Engineering: • Design criteria • Evaluate solutions • Analyze data • Iteratively test and modify	• An organism's body tissue can be damaged by forces applied in collisions. • Engineering designs can protect human body organs in collisions.	• Gravity plays a major role in determining motions with the solar system and galaxies. • Newton's Laws explain the forces and motions of objects on Earth and in space.	• Velocity and mass determine the results of collisions between objects. • Gravitational and electromagnetic fields are the basis of noncontact forces. • Changing the arrangement of objects in a system affects the potential energy stored in that system.

	Course Description	Course Overview	DCIs	Life Science Content	Earth Science Content	Physical Science Content
FOSS Course 4	**FOSS Waves** Students learn about mechanical and electromagnetic waves. They manipulate springs and lasers to determine properties of waves that are eventually used to explain how their cell phones and other modes of modern communications work. They create designs that affect transmission of sound waves in an engineering challenge. 	**Driving question for phenomena:** *How is energy transferred through waves?* **Recommended instructional sequence:** This course relies on the physics foundation of energy and force from courses 2 and 3 as it builds on observable properties of physics to develop a model of electromagnetic waves. Students will apply their understanding of electromagnetic waves and their implications for data transmission when they learn about exploration of the solar system and beyond in Planetary Science.	PS4.A; PS4.B; PS4.C; ETS1.A; ETS1.B; ETS1.C Engineering: • Design criteria • Evaluate solutions • Analyze data • Iteratively test and modify	• The senses of vision and hearing rely on information transmitted by waves. • The visible spectrum is the part of the electromagnetic spectrum humans can detect.	• Ocean waves transfer energy through mechanical waves in water. • Seismic waves reveal information about the interior layers of Earth.	• Waves are reflected, absorbed, or transmitted through various materials. • Wave-based digital technologies provide very reliable ways to encode and transmit information.
FOSS Course 5	**FOSS Planetary Science** Students develop a thorough understanding of the local cosmos—including the organization of the solar system and day/night/seasons—before turning their study to the top planetary science headlines of our times, in particular the hunt for exoplanets. In a capstone project that completes students' middle school science careers, students use satellite images to analyze changes to Earth's systems and draw conclusions about human impact upon Earth's systems. 	**Driving question for phenomena:** *What is my cosmic address?* **Recommended instructional sequence:** This course is recommended to culminate grade 8 as students work on a capstone project drawing from all disciplines. Students draw from courses 2 and 3 to explain orbits and solar system formation. They draw from Waves when considering space science data collection using electromagnetic radiation. In the capstone project, students consider sudden and gradual changes to Earth's systems, ranging from human resource use to meteor impacts, and build on understandings from Heredity and Adaptation to make connections between these events as a driving force that causes evolution of life on Earth.	ESS1.A; ESS1.B; ESS1.C; ESS2.A; ESS2.C; ESS3.A; ESS3.C; ESS3.D; PS2.B; PS4.B; ETS1.A Engineering: • Design criteria	• Living systems are affected by physical changes in the environment. • Sudden changes to the environment can lead to mass extinction events.	• Models explain lunar phases and eclipses of the Sun and Moon. • Annual cycles in the amount of sunlight absorbed cause Earth's seasons. • Gravity plays a major role in determining motions with the solar system and galaxies. • Landforms on celestial objects can indicate presence of water. • Increases in human population and per-capita consumption increase demand for ecosystem services and impact Earth's systems.	• Newton's Laws explain the forces and motions of objects on Earth and in space. • Information transmission via electromagnetic waves is the only way humans can explore far beyond Earth. • Spectra of emitted and absorbed light can reveal presence of water.

Review the Grade 8—FOSS Course Foundation Boxes at the end of this chapter for more details about each course.