INTRODUCTION

Chemistry is the study of the structure of matter and the changes or transformations that take place within those structures. Learning about the properties and behaviors of substances gives us knowledge about how things go together and how they can be taken apart. Learning about changes in substances can lead to the development of new materials and new ways to produce energy. The Mixtures and Solutions Module has four investigations that introduce students to fundamental ideas in chemistry. In this module, students will

• Make and separate mixtures, using screens, filters, and evaporation.
• Measure solids and liquids to compare the mass of a mixture to the mass of its parts.
• Use a balance to determine relative concentration. Layer solutions to determine relative density (concentration).
• Plan and conduct saturation investigations. Compare the solubility of substances in water.
• Identify an unknown substance based on the properties of solubility and crystal form.
• Observe and compare reactants and products of several chemical reactions.
## Module Summary

### Inv. 1: Separating Mixtures

Students make mixtures of water and solid materials and separate the mixtures with screens and filters. They find that water and salt make a special kind of mixture, a solution, which cannot be separated with a filter but only through evaporation. Students are challenged with a problem: how to separate a mixture of three dry solid materials. The investigation concludes with students going outdoors to see what natural materials make solutions with water.

### Inv. 2: Concentration

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 compare them, using a balance. Students determine the relative concentrations of three mystery solutions made from the same solid material by comparing the mass of equal volumes of the solutions. Finally, students layer salt solutions to determine their relative concentrations.

### Inv. 3: Reaching 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.

### Inv. 4: Fizz Quiz

Students make three solutions with water, calcium chloride, baking soda, and citric acid. They systematically mix pairs of those solutions and observe changes that occur. The changes (formation of a gas and a white precipitate) are identified as evidence of a chemical reaction. Students repeat the reactions in sealed zip bags to observe the volume of gas produced. They analyze local water samples, using separation techniques.

## Focus Questions

### How can a mixture be separated?

### Where does the solid material go when a solution is made?

### How can you separate a mixture of dry materials?

### Are there materials outdoors that will dissolve in water?

### Are all solutions made with soft-drink powder and water the same?

### How can you determine which salt solution is more concentrated?

### Do the three mystery solutions have different concentrations?

### Why do salt solutions layer in only one order?

### Is there a limit to the amount of salt that will dissolve in 50 mL of water?

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

### Can you identify the mystery substance by its properties?

### What happens when two substances are mixed with water?

### Is the liquid in Cup 1 a solution?

### What happens when you mix substances with water in a bag?

### What’s in our water samples?
## Content Reading Assessment

- **A mixture is two or more materials intermingled.**
- **An aqueous solution is a mixture in which a substance disappears (dissolves) in water to make a clear liquid.**
- Mixtures can be separated into their constituents by using screen, filters, and evaporation.
- **The mass of a mixture is equal to the mass of its constituents.**

**Science Resources Book**
- "Mixtures"
- "Taking Mixtures Apart"
- "The Story of Salt" (optional)
- "Extracts"

**Assessment**
- **Embedded Assessment**
  - Science notebook entries
  - Response sheet
  - Scientific practices
- **Benchmark Assessment**
  - Survey
  - Investigation 1 I-Check

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- **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.**
- **When equal volumes of two salt solutions are weighed, the heavier one is more concentrated.**
- **Density is mass per unit volume.**
- **More concentrated salt solutions are denser.**
- **Solutions form layers based on density.**

**Science Resources Book**
- "Solutions Up Close"
- "Concentrated Solutions"
- "The Air"
- "Famous Scientists"
- "Carbon Dioxide Concentration in the Air"
- "The Frog Story"

**Assessment**
- **Embedded Assessment**
  - Science notebook entries
  - Response sheet
  - Scientific practices
- **Benchmark Assessment**
  - Investigation 2 I-Check

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- **A substance is a single, pure material.**
- **Solutions are composed of a solvent (liquid) and a solute (solid), which is dissolved in the solvent.**
- **Solubility is the property that indicates how readily a solute dissolves in a solvent.**
- **A solution is saturated when as much solid material as possible has dissolved in the liquid.**
- **Solubility varies from substance to substance.**
- **Substances form predictable, identifiable crystals.**

**Science Resources Book**
- "The Bends"
- "A Sweet Solution"
- "Sour Power"

**Assessment**
- **Embedded Assessment**
  - Science notebook entry
  - Scientific practices
  - Response sheet
- **Benchmark Assessment**
  - Investigation 3 I-Check

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- **Some mixtures result in a chemical reaction.**
- **During reactions, starting substances (reactants) change into new substances (products).**
- **A gas or precipitate is evidence of a reaction.**
- **Some products of reactions are soluble and can be identified by crystal structure after evaporation.**
- **Calcium carbonate reacts with acid.**

**Science Resources Book**
- "Ask a Chemist"
- "When Substances Change"
- "Air Bags"
- "East Bay Academy for Young Scientists"

**Assessment**
- **Embedded Assessment**
  - Science notebook entry
  - Response sheet
  - Scientific practices
- **Benchmark Assessment**
  - Posttest
FOSS CONCEPTUAL FRAMEWORK

FOSS has conceptual structure at the module level. The concepts are carefully selected and organized in a sequence that makes sense to students when presented as intended. In the last half decade, research has been focused on learning progressions. The idea behind a learning progression is that core ideas in science are complex and wide-reaching—ideas such as the structure of matter or the relationship between the structure and function of organisms. From the age of awareness throughout life, matter and organisms are important to us. There are things we can and should understand about them in our primary school years, and progressively more complex and sophisticated things we should know about them as we gain experience and develop our cognitive abilities. When we can determine those logical progressions, we can develop meaningful and effective curriculum.

FOSS has elaborated learning progressions for core ideas in science for kindergarten through grade 6. Developing the learning progressions involves identifying successively more sophisticated ways of thinking about core ideas over multiple years. “If mastery of a core idea in science is the ultimate educational destination, learning progressions are the routes that can be taken to reach that destination” (National Research Council, *A Framework for Science Education*, 2010). Most of this work is behind the scenes, never seen by the user of the FOSS Program. It does surface, however, in two places.

- The conceptual framework represents the structure of scientific knowledge taught and assessed in a module.
- The conceptual flow is a graphic and narrative description of the sequence of ideas, presented in the Background for the Teacher section of each investigation.

The FOSS modules are organized into three domains: physical science, earth science, and life science. Each domain is divided into two strands, which represent a core scientific idea as shown in the columns in the table: matter/energy and change, dynamic atmosphere/rocks and landforms, structure and function/complex systems. The sequence of modules in each strand relates to the core ideas described in the national framework. Modules at the bottom of the table form the foundation in the primary grades. The core ideas develop in complexity as you proceed up the columns.
In addition to the science content framework, every module provides opportunities for students to engage in and understand scientific practices, and many modules explore issues related to engineering practices and the use of natural resources.

The National Research Council (NRC) provides a “set of essential practices as core for any education in the sciences and engineering.”

**Asking questions**
- Ask questions about objects, organisms, systems, and events in the natural and human-made world.

**Collecting, analyzing, and interpreting data**
- Plan and conduct investigations.
- Observe and record data.
- Measure to extend the senses to acquire data.
- Organize observations (data), using numbers, words, images, and graphics.

**Constructing explanations and critiquing arguments**
- Use data and logic to construct and communicate reasonable explanations.
- Develop, discuss, evaluate, and justify the merits of explanations.

**Modeling**
- Create models to explain natural phenomena, and predict future events or outcomes.
- Describe how models represent the natural world.
- Compare models to actual phenomena, and identify limitations of the models.

**Making predictions (devising testable hypotheses)**
- Predict future events, based on evidence and reasoning.
- Discuss, evaluate, and justify predictions.

**Communicating and interpreting science**
- Identify key ideas, identify supporting evidence, and know how to use various text conventions.
- Distinguish opinion from evidence.
- Use writing as a tool for clarifying and communicating ideas.

**Applying and using scientific knowledge**
- Use science-related technologies to apply scientific knowledge to solve problems.
MIXTURES AND SOLUTIONS

CONCEPTUAL FRAMEWORK in Mixtures and Solutions

The Basis of It All

Everything in the known universe can be put into one of two categories: matter or energy. Matter is the material of the universe, and energy is the drive that makes things happen. Chemistry is the study of the properties, relationships, and interactions of matter, and the energy changes that result from chemical interactions.

All the matter on Earth is made up of 90 naturally occurring chemical elements. Some elements are familiar substances, such as sulfur, silver, hydrogen, and iron; some are rare, such as erbium, gadolinium, lutetium, and rhenium. Elements combine in various ways to form the great variety of substances that make up the universe. The elements themselves are made up of atoms, which are the smallest particles into which an element can be divided and yet retain its characteristics.

Atoms are not usually found in pure (element) form, but rather are attached to other atoms in stable associations of molecules. A molecule that contains atoms of more than one element is called a compound. Compounds can be relatively simple, composed of two- or three-atom units, such as water (two hydrogen atoms and one oxygen atom) and carbon dioxide (one carbon atom and two oxygen atoms), or they can be complex, composed of scores of atoms, such as hemoglobin and chlorophyll. Even though thousands of different kinds of molecules have been discovered in nature or manufactured in chemistry labs (dyes, flavors, plastics, lubricants, acids, fuels, on and on), a seemingly infinite array of new molecules could yet be discovered.

On our planet, matter commonly appears in only three natural states—solid, liquid, and gas. A piece of gold is a solid, water is a well-known liquid, and the oxygen in the air we breathe is a gas. Often when a solid is heated, it melts and becomes a liquid. If heating continues, the liquid might vaporize and become a gas. When water cools enough, it turns into a solid called ice. When water warms, it evaporates, turning into a gas called water vapor. These changes of state are interesting to the chemist because they often take up or give off energy.
Putting Different Kinds of Matter Together

When two or more kinds of matter are combined, the result is a mixture. Simple mixtures include sand and water, oil and vinegar, nuts and bolts, coleslaw, rocky road ice cream, and trail mix. Mixtures can be made with any combination of gases, liquids, and solids. Once assembled, mixtures can be separated using physical means, such as hand separation, screening, filtering, and evaporation. The components of a mixture are not changed by mixing with other materials. The resulting mass of a mixture is the sum of the masses of the components.

Sometimes when two (or more) materials are mixed, a different kind of mixture results. For example, when salt and water are mixed, the solid salt seems to disappear in the water. This process is called dissolving; we say that the salt dissolved in the water. This mixture is a solution. When a solid dissolves in a liquid, the liquid is the solvent, and the solid material is the solute. All mixtures can be separated by physical means. A solution of a liquid and a solid can be separated by evaporating the liquid (the solvent). If a solution is heated so that the solvent changes phase from liquid to gas, the gas will escape into the air, leaving the salt behind.

Most solutions are made by mixing a solid and a liquid, but mixtures of matter in other states can also form solutions. Air is a solution made of several gases, including nitrogen, oxygen, helium, carbon dioxide, and small amounts of many other gases. Brass is a solid solution made from zinc and copper. Carbonated water is a solution of carbon dioxide gas dissolved in liquid water. In fact, any mixture in which the particles are distributed uniformly throughout, and no particle is larger than 5 nanometers (nm), is a solution. A nanometer is one-billionth of a meter, so 5 nm is a particle of tiny dimensions.
Investigating Solutions

Solid/liquid solutions can differ from one another in two significant ways. First, they can be made from different materials. A salt-and-water solution is obviously different from a sugar-and-water solution, especially to anyone who has made a substitution error when making lemonade. Second, solutions can be made from the same materials, but the ratio of solute (the solid) to solvent (the liquid) can differ. This ratio is called concentration. Solutions with a high ratio of solute to solvent are concentrated solutions. Solutions with a low ratio of solute to solvent are dilute solutions.

Consider a salt-and-water solution. A spoonful of table salt (sodium chloride) dissolves in a glass of water, making a dilute, clear, colorless solution. A second spoonful and then a third will dissolve in the water, making the solution more concentrated with each additional spoonful of salt. However, an interesting thing happens when the fourth spoonful of salt is added: it sits on the bottom of the glass and does not dissolve. All solutions eventually reach a point where no more solute can dissolve in the solvent. When this happens, the solution has reached its maximum concentration and is said to be saturated. The amount of solid material needed to saturate a given volume of water varies greatly, depending on the solute used. For instance, only a gram (g) or two of sodium bicarbonate (baking soda) saturates 50 milliliters (mL) of water, but more than 50 g of citric acid saturates the same volume of water.

Separating solutions into their component parts can usually be accomplished by evaporation. In evaporation, the solvent vaporizes (turns into a gas) and is carried off by the surrounding air. The solute is left behind. In most cases, the solid material comes out of solution as distinctive crystals. Each kind of solid material has its own natural form, dictated by the way the material’s particles align with one another. Salt forms cubic crystals; calcium acetate forms long, needlelike crystals; and Epsom salts forms six-sided polygons.

When a solid material dissolves and seems to disappear in a liquid, it undergoes a physical change. The size of the particles or the way the particles relate to one another may change, but it is still the same material.
Chemical Reactions

When two solutions are mixed, another kind of change could take place—a chemical change. When this happens, the result is a chemical reaction. The starting substances (reactants) change into new substances (products). New materials form as a result of chemical reactions, and it is not possible to retrieve the original materials without another chemical reaction.

Consider this example of a chemical reaction: you have excess hydrochloric acid, giving you a pain in the stomach. You make a solution using an antacid tablet containing baking soda (sodium bicarbonate) and drink it. In your stomach, the two materials mix and react. The acid and baking soda are used up, and new products form: sodium chloride (table salt), water, and carbon dioxide. Voilà! No more stomachache. The carbon dioxide is released with a belch, the salt is dispatched by the bloodstream, and a little extra water is gained.
**Matter Content Sequence**

This table shows the five FOSS modules and courses that address the matter content sequence, grades K–8. Running through the sequence are the two progressions—matter has structure, and matter interacts. The supporting elements in each module (somewhat abbreviated) are listed. The elements for the **Mixtures and Solutions Module** are expanded to show how they fit into the sequence.

<table>
<thead>
<tr>
<th>Module or course</th>
<th>Matter has structure</th>
<th>Matter interacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chemical Interactions</strong></td>
<td>• Matter is made of atoms.</td>
<td>• During chemical reactions, particles in reactants rearrange to form new products.</td>
</tr>
<tr>
<td></td>
<td>• Substances are defined by chemical formulas.</td>
<td>• Energy transfer to/from the particles in a substance can result in phase change.</td>
</tr>
<tr>
<td></td>
<td>• Elements are defined by unique atoms.</td>
<td>• During dissolving, one substance is reduced to particles (solute), which are distributed uniformly throughout the particles of the other substance (solvent).</td>
</tr>
<tr>
<td></td>
<td>• The properties of matter are determined by the kinds and behaviors of its atoms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Atomic theory explains the conservation of matter.</td>
<td></td>
</tr>
<tr>
<td><strong>Mixtures and Solutions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Properties of matter (solid, liquid, gas) can be described using measurement</td>
<td>• Different substances change state (e.g., melt or freeze) at different temperatures.</td>
</tr>
<tr>
<td></td>
<td>(length, mass, volume, temperature).</td>
<td>• Mass is conserved when objects or materials are mixed.</td>
</tr>
<tr>
<td></td>
<td>• Measurement can be used to confirm that the whole is equal to its parts.</td>
<td></td>
</tr>
<tr>
<td><strong>Measuring Matter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Common matter is solid, liquid, and gas.</td>
<td>• Solids interact with water in various ways: float, sink, dissolve, swell, change.</td>
</tr>
<tr>
<td></td>
<td>• Solid matter has definite shape.</td>
<td>• Liquids interact with water in various ways: layer, mix, change color.</td>
</tr>
<tr>
<td></td>
<td>• Liquid matter has definite volume.</td>
<td>• Substances change state (e.g., melt or freeze) when heated or cooled.</td>
</tr>
<tr>
<td></td>
<td>• Gas matter has neither definite shape nor volume and expands to fill containers.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Intrinsic properties of matter can be used to organize objects (e.g., color, shape).</td>
<td></td>
</tr>
<tr>
<td><strong>Solids and Liquids</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Wood, paper, rock, and fabric are examples of solid materials.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Solid objects are made of solid materials.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Solid objects have properties.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The whole (object) can be broken into smaller pieces.</td>
<td></td>
</tr>
<tr>
<td><strong>Materials in Our World</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Wood, paper, and fabric can be changed by sanding, coloring, tearing, etc.</td>
<td>• Common materials can be changed into new materials (paper making, weaving, etc.).</td>
</tr>
<tr>
<td></td>
<td>• Common materials can be changed into new materials (paper making, weaving, etc.).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Water can change to ice in a freezer, and ice can change to water in a room.</td>
<td></td>
</tr>
</tbody>
</table>
The Mixtures and Solutions Module aligns with the NRC Framework. Here are the upper elementary questions from the national framework that are addressed in this module.

Physical Science

Core idea: structure and properties of matter

- How do the parts of an object affect its structure and function (macroscopic)?
- What characteristics are useful for describing and classifying substances?

Core idea: interactions, stability, and change

- What happens to the parts of a system when the system changes?

<table>
<thead>
<tr>
<th>Matter has structure</th>
<th>Matter interacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid matter can break into pieces too small to see.</td>
<td>A mixture is two or more intermingled substances.</td>
</tr>
<tr>
<td>Mass is conserved (not created or lost) during changes.</td>
<td>Dissolving occurs when one substance disappears in a second substance.</td>
</tr>
<tr>
<td>Properties can be used to identify substances (e.g., solubility).</td>
<td>A chemical reaction occurs when substances mix and new products result.</td>
</tr>
<tr>
<td>Relative density can be used to seriate solutions of different concentrations.</td>
<td>Melting is an interaction between one substance and heat.</td>
</tr>
</tbody>
</table>

Engineering and Technology

Core idea: the designed world

- What is technology?
- How are tools used to change materials?

Core idea: engineering design

- How can different solutions (to a problem) be clearly expressed?
- How can the best solution be chosen?
- How can different ideas be combined?
FOSS COMPONENTS

Teacher Toolkit

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
- Materials
- Investigations (four in this module)

Teacher Resources. This three-ring binder contains these chapters.

- FOSS Introduction
- Assessment
- Science Notebooks in Grades 3–6
- Science-Centered Language Development
- Taking FOSS Outdoors
- FOSSweb and Technology
- Science Notebook Masters
- Teacher Masters
- Assessment Masters

The chapters contained in the Teacher Resources and the Spanish duplication masters can also be found on FOSSweb (www.FOSSweb.com) and on CDs included in the Teacher Toolkit.

FOSS Science Resources book. This is a copy of the student book of readings that are integrated into the instruction.

Equipment Kit

The FOSS Program provides the materials needed for the investigations, including metric measuring tools, 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 two uses before you need to resupply. Teachers may be asked to supply small quantities of common classroom items.
FOSS Components

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 the Investigations Guide. Students read the articles in the book as they progress through the module. The articles cover a specific concept usually after that concept has been introduced in an active investigation.

The articles in Science Resources and the discussion questions provided in the 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.

FOSSweb and Technology

The FOSS website opens new horizons for educators, students, and families, in the classroom or at home. Each module has an interactive site where students and families can find instructional activities, interactive simulations and virtual investigations, and other additional resources. FOSSweb provides resources for materials management, general teaching tools for FOSS, purchasing links, contact information for the FOSS Project, and technical support. You do not need an account to view this general FOSS Program information. In addition to the general information, FOSSweb provides digital access to PDF versions of the Teacher Resources component of the Teacher Toolkit and digital-only resources that supplement the print and kit materials.

Additional resources are available to support FOSS teachers. 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.

Ongoing Professional Development

The Lawrence Hall of Science and Delta Education are committed to supporting science educators with unrivaled teacher support, high-quality implementation, and continuous staff-development opportunities and resources. FOSS has a strong network of consultants who have rich and experienced backgrounds in diverse educational settings using FOSS. Find out about professional-development opportunities on FOSSweb.

Mixtures and Solutions Module

NOTE
To access all the teacher resources and to set up customized pages for using FOSS, log in to www.FOSSweb.com through an educator account.
FOSS INSTRUCTIONAL DESIGN

Each FOSS investigation follows a similar design to provide multiple exposures to science concepts. The design includes these pedagogies.

- Active investigation, including outdoor experiences
- Recording in science notebooks to answer the focus question
- Reading in FOSS Science Resources
- Assessment to monitor progress and motivate student reflection on learning

In practice, these components are seamlessly integrated into a continuum designed to maximize every student’s opportunity to learn. An instructional sequence may move from one pedagogy to another and back again to ensure adequate coverage of a concept.

FOSS Investigation Organization

Modules are subdivided into investigations (four in this module). Investigations are further subdivided into 3–5 parts. Each part of each investigation is driven by a focus question. The focus question, usually presented as the part begins, signals the challenge to be met, mystery to be solved, or principle to be uncovered. The focus question guides students’ actions and thinking and makes the learning goal of each part explicit for teachers. Each part concludes with students recording an answer to the focus question in their notebooks.

Investigation-specific scientific background information for the teacher is presented in each investigation. The content discussion is divided into sections, each of which relates directly to one of the focus questions. This section ends with information about teaching and learning and a conceptual-flow diagram for the content.

The Getting Ready and Guiding the Investigation sections have several features that are flagged or presented in the sidebars. These include several icons to remind you when a particular pedagogical method is suggested, as well as concise bits of information in several categories.

Teaching notes appear in blue boxes in the sidebars. These notes comprise a second voice in the curriculum—an educative element. The first (traditional) voice is the message you deliver to students. It supports your work teaching students at all levels, from management to inquiry. The second educative voice, shared as a teaching note, is designed to help you understand the science content and pedagogical rationale at work behind the instructional scene.
The safety icon reminds you to be aware of a potential safety issue. It could relate to the use of a chemical substance, such as salt, requiring safety goggles, or the possibility of a student allergic reaction when latex, legumes, or wheat are in use.

The small-group discussion icon asks you to pause while students discuss data or construct explanations in their groups. Often, a Reporter shares the group’s conclusions with the class.

The new-word icon alerts you to a new vocabulary word or phrase that should be introduced thoughtfully. The new vocabulary should also be entered onto the word wall (or pocket chart). A complete list of the scientific vocabulary used in each investigation appears in the sidebar on the last page of the Background for the Teacher section.

The vocabulary icon indicates where students should review recently introduced vocabulary, often just before they will be answering the focus question or preparing for benchmark assessment.

The recording icon points out where students should make a science-notebook entry. Students record on prepared notebook sheets or, increasingly, on pages in their science notebooks.

The reading icon signals when the class should read a specific article in the FOSS Science Resources book, preferably during a reading period.

The assessment icon appears when there is an opportunity to assess student progress by using embedded or benchmark assessments. Some of the embedded-assessment methods for grades 3–6 include observation of students engaged in scientific practices, review of a notebook entry, and a response sheet.

The outdoor icon signals when to move the science learning experience into the schoolyard. It also helps you plan for selecting and preparing an outdoor site for a student activity.

The engineering icon indicates opportunities for addressing engineering practices—applying and using scientific knowledge. These opportunities include developing a solution to a problem, constructing and evaluating models, and using systems thinking.

The EL Note in the sidebar provides a specific strategy to use to assist English learners in developing science concepts. A discussion of strategies is in the Science-Centered Language Development chapter.

To help with pacing, you will see icons for breakpoints. Some breakpoints are essential, and others are optional.
Active Investigation

Active investigation is a master pedagogy. Embedded within active learning are a number of pedagogical elements and practices that keep active investigation vigorous and productive. The enterprise of active investigation includes

- **context**: questioning and planning;
- **activity**: doing and observing;
- **data management**: recording/organizing/processing;
- **analysis**: discussing and writing explanations.

**Context: questioning and planning.** Active investigation requires focus. The context of an inquiry can be established with a focus question or challenge from you, or in some cases, from students. How can you separate a mixture of three solid materials? At other times, students are asked to plan a method for investigation. This might start with a teacher demonstration or presentation. Then you challenge students to plan an investigation, such as to find how much solid material will dissolve in a unit of water. In either case, the field available for thought and interaction is limited. This clarification of context and purpose results in a more productive investigation.

**Activity: doing and observing.** In the practice of science, scientists put things together and take things apart, they observe systems and interactions, and they conduct experiments. This is the core of science—active, firsthand experience with objects, organisms, materials, and systems in the natural world. In FOSS, students engage in the same processes. Students often conduct investigations in collaborative groups of four, with each student taking a role to contribute to the effort.

The active investigations in FOSS are cohesive, and build on each other and the readings to lead students to a comprehensive understanding of concepts. Through the investigations, students gather meaningful data.

**Data management: recording/organizing/processing.** Data accrue from observation, both direct (through the senses) and indirect (mediated by instrumentation). Data are the raw material from which scientific knowledge and meaning are synthesized. During and after work with materials, students record data in their notebooks. Data recording is the first of several kinds of student writing.

Students then organize data so that they will be easier to think about. Tables allow efficient comparison. Organizing data in a sequence (time) or series (size) can reveal patterns. Students process some data into graphs, providing visual display of numerical data. They also organize data and process them in the science notebook.
**Analysis: discussing and writing explanations.** The most important part of an active investigation is extracting its meaning. This constructive process involves logic, discourse, and existing knowledge. Students share their explanations for phenomena, using evidence generated during the investigation to support their ideas. They conclude the active investigation by writing in their science notebooks a summary of their learning as well as questions raised during the activity.

**Science Notebooks**

Research and best practice have led FOSS to place more emphasis on the student science notebook. Keeping a notebook helps students organize their observations and data, process their data, and maintain a record of their learning for future reference. The process of writing about their science experiences and communicating their thinking is a powerful learning device for students. And the science notebook entries stand as a credible and useful expression of learning. The artifacts in the notebooks form one of the core elements of the assessment system.

You will find the duplication masters for grades 1–6 presented in notebook format. They are reduced in size (two copies to a standard sheet) for placement (glue or tape) in a bound composition book. Full-size duplication masters are also available on FOSSweb. Student work is entered partly in spaces provided in the notebook sheets and partly on adjacent blank sheets.

| Mixture—two or more materials together. |
| Dissolve—when a solid disappears in a liquid. |
| Solution—a mixture in which a solid dissolved in a liquid. |
| Mixture—two or more materials together. |
| Dissolve—when a solid disappears in a liquid. |
| Solution—a mixture in which a solid dissolved in a liquid. |

You can separate gravel and water with a screen. You can separate powder and...
Reading in FOSS Science Resources

The FOSS Science Resources books emphasize expository articles and biographical sketches. FOSS suggests that the reading be completed during language-arts time. When language-arts skills and methods are embedded in content material that relates to the authentic experience students have had during the FOSS active learning sessions, students are interested, and they get more meaning from the text material.

Assessing Progress

The FOSS assessment system includes both formative and summative assessments. Formative assessment monitors learning during the process of instruction. It measures progress, provides information about learning, and is generally diagnostic. Summative assessment looks at the learning after instruction is completed, and it measures achievement.

Formative assessment in FOSS, called embedded assessment, occurs on a daily basis. You observe action during class or review notebooks after class. Embedded assessment provides continuous monitoring of students’ learning and helps you make decisions about whether to review, extend, or move on to the next idea to be covered.

Benchmark assessments are short summative assessments given after each investigation. These I-Checks are actually hybrid tools: they provide summative information about students’ achievement, and because they occur soon after teaching each investigation, they can be used diagnostically as well. Reviewing a specific item on an I-Check with the class provides another opportunity for students to clarify their thinking.

The embedded assessments are based on authentic work produced by students during the course of participating in the FOSS activities. Students do their science, and you look at their notebook entries. Within the instructional sequence, you will see the heading What to Look For in red letters. Under that, you will see bullet points telling you specifically what students should know and be able to communicate.
20. Assess progress: notebook entry
Collect students’ notebooks. After class, check the definitions and answers to the focus question to see if students have an adequate understanding of mixture, dissolve, and solution.

**What to Look For**
- Students define **mixture** (two or more materials together), **dissolve** (when a solid disappears in a liquid), and **solution** (a mixture in which a solid substance dissolves in water to make a clear liquid).
- Students know that solutions are composed of a solvent (liquid) and a solute (solid) that is dissolved in the solvent.
- Students know that mixtures can be separated back into the original materials, using screens and filters.

If student work is incorrect or incomplete, you know that there has been a breakdown in the learning/communicating process. The assessment system then provides a menu of next-step strategies to resolve the situation. Embedded assessment is assessment for learning, not assessment of learning.

Assessment of learning is the domain of the benchmark assessments. Benchmark assessments are delivered at the beginning of the module (Survey) and at the end of the module (Posttest), and after each investigation (I-Checks). The benchmark tools are carefully crafted and thoroughly tested assessments composed of valid and reliable items. The assessment items do not simply identify whether or not a student knows a piece of science content. They identify the depth to which students understand science concepts and principles and the extent to which they can apply that understanding. Since the output from the benchmark assessments is descriptive and complex, it can be used for formative as well as summative assessment.

Completely incorporating the assessment system into your teaching practice involves realigning your perception of the interplay between good teaching and good learning, and usually leads to a considerably different social order in the classroom with redefined student-student and teacher-student relationships.
Taking FOSS Outdoors

FOSS throws open the classroom door and proclaims the entire school campus to be the science classroom. The true value of science knowledge is its usefulness in the real world and not just in the classroom. Taking regular excursions into the immediate outdoor environment has many benefits. First of all, it provides opportunities for students to apply things they learned in the classroom to novel situations. When students are able to transfer knowledge of scientific principles to natural systems, they experience a sense of accomplishment.

In addition to transfer and application, students can learn things outdoors that they are not able to learn indoors. The most important object of inquiry outdoors is the outdoors itself. To today’s youth, the outdoors is something to pass through as quickly as possible to get to the next human-managed place. For many, engagement with the outdoors and natural systems must be intentional, at least at first. With repeated visits to familiar outdoor learning environments, students may first develop comfort in the outdoors, and then a desire to embrace and understand natural systems.

The last part of most investigations is an outdoor experience. Venturing out will require courage the first time or two you mount an outdoor expedition. It will confuse students as they struggle to find the right behavior that is a compromise between classroom rigor and diligence and the freedom of recreation. With persistence, you will reap rewards. You will be pleased to see students’ comportment develop into proper field-study habits, and you may be amazed by the transformation of students with behavior issues in the classroom who become your insightful observers and leaders in the schoolyard environment.

Teaching outdoors is the same as teaching indoors—except for the space. You need to manage the same four core elements of teaching: time, space, materials, and students. Because of the different space, new management procedures are required. Students can get farther away. Materials have to be transported. The space has to be defined and honored. Time has to be budgeted for getting to, moving around in, and getting from the outdoor study site. All these and more issues and solutions are discussed in the Taking FOSS Outdoors chapter in the Teacher Resources.

FOSS is very enthusiastic about this dimension of the program and looks forward to hearing about your experience using the schoolyard as a logical extension of your classroom.
Science-Centered Language Development

The FOSS active investigations, science notebooks, FOSS Science Resources articles, and formative assessments provide rich contexts in which students develop and exercise thinking and communication. These elements are essential for effective instruction in both science and language arts—students experience the natural world in real and authentic ways and use language to inquire, process information, and communicate their thinking about scientific phenomena. FOSS refers to this development of language process and skills within the context of science as science-centered language development.

In the Science-Centered Language Development chapter in the Teacher Resources, we explore the intersection of science and language and the implications for effective science teaching and language development. We identify best practices in language-arts instruction that support science learning and examine how learning science content and engaging in scientific practices support language development.

Language plays two crucial roles in science learning: (1) it facilitates the communication of conceptual and procedural knowledge, questions, and propositions, and (2) it mediates thinking—a process necessary for understanding. For students, language development is intimately involved in their learning about the natural world. Science provides a real and engaging context for developing literacy, and language-arts skills and strategies support conceptual development and scientific practices. For example, the skills and strategies used for enhancing reading comprehension, writing expository text, and exercising oral discourse are applied when students are recording their observations, making sense of science content, and communicating their ideas. Students’ use of language improves when they discuss (speak and listen, as in the Wrap-Up/Warm-Up activities), write, and read about the concepts explored in each investigation.

There are many ways to integrate language into science investigations. The most effective integration depends on the type of investigation, the experience of students, the language skills and needs of students, and the language objectives that you deem important at the time. The Science-Centered Language Development chapter is a library of resources and strategies for you to use. The chapter describes how literacy strategies are integrated purposefully into the FOSS investigations, gives suggestions for additional literacy strategies that both enhance students’ learning in science and develop or exercise English-language literacy skills, and develops science vocabulary with scaffolding strategies for supporting all learners. The last section covers language-development strategies specifically for English learners.
FOSSWEB AND TECHNOLOGY

FOSS is committed to providing a rich, accessible technology experience for all FOSS users. FOSSweb is the Internet access to FOSS digital resources. It provides enrichment for students and support for teachers, administrators, and families who are actively involved in implementing and enjoying FOSS materials. Here are brief descriptions of selected resources to help you get started with FOSS technology.

Technology to Engage Students at School and Home

*Multimedia activities.* The multimedia simulations and activities were designed to support student learning. They include virtual investigations and student tutorials that you can use to support students who have difficulties with the materials or who have been absent.

*FOSS Science Resources.* The student reading book is available as an audio book on FOSSweb, accessible at school or at home. In addition, as premium content, *FOSS Science Resources* is available as an eBook. The eBook supports a range of font sizes and can be projected for guided reading with the whole class as needed.

*Home/school connection.* Each module includes a letter to families that provides an overview of the goals and objectives of the module. Most investigations have a home/school activity that provides science experiences to connect the classroom experiences with students’ life outside of school. These connections are available in print in the *Teacher Resources* binder and on FOSSweb.

*Student media library.* A variety of media enhance student learning. Formats include photos, videos, an audio version of each student book, and frequently asked science questions. These resources are also available to students when they log in with a student account.

*Recommended books and websites.* FOSS has reviewed print books and digital resources that are appropriate for students and prepared a list of these media resources.

*Class pages.* Teachers with a FOSSweb account can easily set up class pages with notes and assignments for each class. Students and families can access this class information online.
Technology to Support Teachers

Teacher-preparation video. The video presents information to help you prepare for a module, including detailed investigation information, equipment setup and use, safety, and what students do and learn through each part of the investigation.

Science-notebook masters and teacher masters. All notebook masters and teacher masters used in the modules are available digitally on FOSSweb for downloading and for projection during class. These sheets are available in English and Spanish.

Assessment masters. The benchmark assessment masters for grades 1–6 are available in English and Spanish.

Focus questions. The focus questions for each investigation are formatted for classroom projection and for printing onto labels that students can glue into their science notebooks.

Equipment photo cards. The cards provide labeled photos of equipment supplied in the FOSS kit.

Materials Safety Data Sheets (MSDS). These sheets have information from materials manufacturers on handling and disposal of materials.

Teacher Resources chapters. FOSSweb provides PDF files of all chapters from the Teacher Resources binder.

- Assessment
- Science Notebooks
- Science-Centered Language Development
- Taking FOSS Outdoors
- FOSSweb and Technology

Streaming video. Some video clips are part of the instruction in the investigation, and others extend concepts presented in a module.

Resources by investigation. This digital listing provides online links to notebook sheets, assessment and teacher masters, and multimedia for each investigation of a module for projection in the classroom.

Interactive whiteboard resources. You can use these slide shows and other resources with an interactive whiteboard.

Investigations eGuide. The eGuide is the complete Investigations Guide component of the Teacher Toolkit in an electronic web-based format, allowing access from any Internet-enabled computer. This resource is premium content.

NOTE
The Spanish masters are only available on FOSSweb and on one of the CDs provided in the Teacher Toolkit.
Module summary. The summary describes each investigation in a module, including major concepts developed.

Module updates. These are important updates related to the teacher materials, student equipment, and safety guidelines.

Module teaching notes. These notes include teaching suggestions and enhancements to the module, sent in by experienced FOSS users.

FOSSmap and online assessments. A computerized assessment program, called FOSSmap, provides a system for students to take assessments online, and for you to review those assessments online and to assign tutorial sessions for individual students based on assessment performance. You generate a password for students to access and take the assessments online.

Most assessment items are multiple-choice, multiple-answer, or short-answer questions, but for one or two questions, students must write sentences. These open-response questions can be answered either online or using paper and pencil.

After students have completed a benchmark assessment, FOSSmap automatically codes (scores) the multiple-choice, multiple-answer, and short-answer questions. You will need to check students’ responses for short-answer questions to make sure that the questions have been coded correctly. Students’ open-response questions are systematically displayed for coding. If students have taken any part of the test via paper and pencil, you will need to enter students’ answers on the computer for multiple-choice and multiple-answer questions (the computer automatically codes the answers), and to code the short-answer and open-response questions.

Once the codes are in the FOSSmap program, you can generate and display several reports.

The Code-Frequency Report is a bar graph showing how many students received each code. This graph makes it easy to see which items might need further instruction.

In the Class-by-Item Report, each item is presented in a text format that indicates a percentage and provides names of students who selected each answer. It also describes what a code means in terms of what students know or need to work on.

The Class-by-Level Report describes four levels of achievement. It lists class percentages and students who achieved each level.
The Class-Frequency Report has bar graphs indicating how many students achieved each level. The survey and posttest are shown on the same page for easy comparison. I-Checks appear on separate pages.

The Student-by-Item Report is available for each student. It provides information about the highest code possible, the code the student received, and a note describing what the student knows or what he or she needs to work on. This report also suggests online tutorials to assign to students who need additional help.

The Student Assessment Summary bar graph indicates the level achieved by individual students on all the assessments taken up to any point in the module. This graph makes it easy to compare achievement on the survey and posttest as well as on each I-Check.

**Tutorials.** You can assign online tutorials to individual students, based on how each student answers questions on the I-Checks and posttest. The Student-by-Item Report, generated by FOSSmap, indicates the tutorials specifically targeted to help individual students to refine their understandings. Tutorials are an excellent tool for differentiating instruction and are available to students at any time on FOSSweb.
UNIVERSAL DESIGN FOR LEARNING

The roots of FOSS extend back to the mid-1970s and the Science Activities for the Visually Impaired and Science Enrichment for Learners with Physical Handicaps projects (SAVI/SELPH). As those special-education science programs expanded into fully integrated settings in the 1980s, hands-on science proved to be a powerful medium for bringing all students together. The subject matter is universally interesting, and the joy and satisfaction of discovery are shared by everyone. Active science by itself provides part of the solution to full inclusion.

Many years later, FOSS began a collaboration with educators and researchers at the Center for Applied Special Technology (CAST), where principles of Universal Design for Learning (UDL) had been developed and applied. FOSS continues to learn from our colleagues about ways to use new media and technologies to improve instruction. Here are the UDL principles.

Principle 1. Provide multiple means of representation. Give learners various ways to acquire information and knowledge.


The FOSS Program has been designed to maximize the science-learning opportunities for students with special needs and students from culturally and linguistically diverse origins. FOSS is rooted in a 30-year tradition of multisensory science education and informed by recent research on UDL. Procedures found effective with students with special needs and students learning English are incorporated into the materials and procedures used with all students.

English Learners

The FOSS multisensory program provides a rich laboratory for language development for English learners. The program uses a variety of techniques to make science concepts clear and concrete, including modeling, visuals, and active investigations in small groups at centers. Key vocabulary is usually developed within an activity context with frequent opportunities for interaction and discussion between teacher and student and among students. This provides practice and application
of the new vocabulary. Instruction is guided and scaffolded through carefully designed lesson plans, and students are supported throughout. The learning is active and engaging for all students, including English learners.

Science vocabulary is introduced in authentic contexts while students engage in active learning. Strategies for helping all elementary students read, write, speak, and listen are described in the Science-Centered Language Development chapter. There is a section on science-vocabulary development with scaffolding strategies for supporting English learners. These strategies are essential for English learners, and they are good teaching strategies for all learners.

**Differentiated Instruction**

FOSS instruction allows students to express their understanding through a variety of modalities. Each student has multiple opportunities to demonstrate his or her strengths and needs. The challenge is then to provide appropriate follow-up experiences for each student. For some students, appropriate experience might mean more time with the active investigations. For other students, it might mean more experience building explanations of the science concepts orally or in writing or drawing. For some students, it might mean making the vocabulary more explicit through new concrete experiences or through reading to the students. For some students, it may be scaffolding their thinking through graphic organizers. For other students, it might be designing individual projects or small-group investigations. And for some students, it might be more opportunities for experiencing science outside of the classroom in more natural, outdoor environments.

There are several possible strategies for providing differentiated instruction. The FOSS Program provides tools and strategies so that you know what students are thinking throughout the module. Based on that knowledge, read through the extension activities for experiences that might be appropriate for students who need additional practice with the basic concepts as well as those ready for more advanced projects. Interdisciplinary extensions are listed at the end of each investigation. Use these ideas to meet the individual needs and interests of your students.
WORKING IN COLLABORATIVE GROUPS

Collaboration is important in science. Scientists usually collaborate on research enterprises. Groups of researchers often contribute to the collection of data, the analysis of findings, and the preparation of the results for publication.

Collaboration is expected in the science classroom, too. Some tasks call for everyone to have the same experience, either taking turns or doing the same things simultaneously. At other times, group members may have different experiences that they later bring together.

Research has shown that students learn better and are more successful when they collaborate. Working together promotes student interest, participation, learning, and self-confidence. FOSS investigations use collaborative groups extensively.

No single model for collaborative learning is promoted by FOSS. We can suggest, however, a few general guidelines that have proven successful over the years.

For most activities in upper-elementary grades, collaborative groups of four in which students take turns assuming specific responsibilities work best. Groups can be identified completely randomly (first four names drawn from a hat constitute group 1), or you can assemble groups to ensure diversity. Thoughtfully constituted groups tend to work better.

Groups can be maintained for extended periods of time, or they can be reconfigured more frequently. Six to nine weeks seems about optimum, so students might stay together throughout an entire module.

Functional roles within groups can be determined by the members themselves, or they can be assigned in one of several ways. Each member in a collaborative group can be assigned a number or a color. Then you need only announce which color or number will perform a certain task for the group at a certain time. Compass points can also be used: the person seated on the east side of the table will be the Reporter for this investigation.

The functional roles used in the investigations follow. If you already use other names for functional roles in your class, use them in place of those in the investigations.
**Mixtures and Solutions Module**

**Getting in Collaborative Groups**

Getters are responsible for materials. One person from each group gets equipment from the materials station, and another person later returns the equipment.

One person is the Starter for each task. This person makes sure that everyone gets a turn and that everyone has an opportunity to contribute ideas to the investigation.

The Reporter makes sure that everyone has recorded information on his or her science notebook sheets. This person reports group data to the class or transcribes it to the board or class chart.

Getting started with collaborative groups requires patience, but the rewards are great. Once collaborative groups are in place, you will be able to engage students more in meaningful conversations about science content. You are free to “cruise” the groups, to observe and listen to students as they work, and to interact with individuals and small groups as needed.

**When Students Are Absent**

When a student is absent for a session, give him or her a chance to spend some time with the materials at a center. Another student might act as a peer tutor. Allow the student to bring home a FOSS Science Resources book to read with a family member. Each article has a few review items that the student can respond to verbally or in writing.

There is a set of two or three virtual investigations for each FOSS module for grades 3–6. Students who have been absent from certain investigations can access these simulations online through FOSSweb. The virtual investigations require students to record data and answer concluding questions in their science notebooks. Sometimes the notebook sheet that was used in the classroom investigation is also used for the virtual investigation.
SAFETY IN THE CLASSROOM AND OUTDOORS

Following the procedures described in each investigation will make for a very safe experience in the classroom. You should also review your district safety guidelines and make sure that everything you do is consistent with those guidelines. Two posters are included in the kit: Science Safety for classroom use and Outdoor Safety for outdoor activities.

Look for the safety-note icon in the Getting Ready and Guiding the Investigation sections, which will alert you to safety considerations throughout the module.

Materials Safety Data Sheets (MSDS) for materials used in the FOSS program can be found on FOSSweb. If you have questions regarding any MSDS, call Delta Education at 800-258-1302 (Monday-Friday 8 a.m. to 6 p.m. EST).

Science Safety in the Classroom

General classroom safety rules to share with students are listed here.

1. Listen carefully to your teacher’s instructions. Follow all directions. Ask questions if you don’t know what to do.
2. Tell your teacher if you have any allergies.
3. Never put any materials in your mouth. Do not taste anything unless your teacher tells you to do so.
4. Never smell any unknown material. If your teacher tells you to smell something, wave your hand over the material to bring the smell toward your nose.
5. Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.
6. Always protect your eyes. Wear safety goggles when necessary. Tell your teacher if you wear contact lenses.
7. Always wash your hands with soap and warm water after handling chemicals, plants, or animals.
8. Never mix any chemicals unless your teacher tells you to do so.
9. Report all spills, accidents, and injuries to your teacher.
10. Treat animals with respect, caution, and consideration.
11. Clean up your work space after each investigation.
12. Act responsibly during all science activities.

Science Safety

Listen carefully to your teacher’s instructions. Follow all directions. Ask questions if you don’t know what to do.

1. Tell your teacher if you have any allergies. Let your teacher know if you have never been stung by a bee.
2. Never put any materials in your mouth.
3. Dress appropriately for the weather and the outdoor experience.
4. Stay within the designated study area and with your partner or group. When you hear the “freeze” signal, stop and listen to your teacher.
5. Never look directly at the Sun or at the sunlight being reflected off a shiny object.
6. Know if there are any skin-irritating plants in your schoolyard, and do not touch them. Most plants in the schoolyard are harmless.
7. Respect all living things. When looking under a stone or log, lift the side away from you so that any living thing can escape.
8. If a stinging insect is near you, stay calm and slowly walk away from it. Tell your teacher right away if you are stung or bitten.
9. Never release any living things into the environment where you collected them.
10. Always wash your hands with soap and warm water after handling plants, animals, and soil.
11. Return to the classroom with all of the materials you brought outside.
12. Act responsibly during all science activities.
Scheduling the Module

Below is a suggested teaching schedule for the module. The investigations are numbered and should be taught in order, as the concepts build upon each other from investigation to investigation. We suggest that a minimum of 9 weeks be devoted to this module. Take your time, and explore the subject thoroughly.

**Active-investigation (A)** sessions include hands-on work with mixtures, solutions, and chemical reactions; active thinking about the concrete experiences; small-group discussion; writing in science notebooks; learning new vocabulary in context; and completing written embedded assessments to inform instruction.

**Wrap-Up/Warm-Up (W)** sessions involve students in sharing notebook entries and discussing their answers to the focus question.

**Reading (R)** sessions (FOSS Science Resources book) include individual and interactive reading and discussing the reading to ensure that students integrate the information.

**I-Checks** are short assessments at the end of each investigation. Students respond to written prompts. The next day, after you have coded the assessments, students self-assess their written responses on a few critical items to reflect on and improve their understanding.

<table>
<thead>
<tr>
<th>Week</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>Survey</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>START Inv. 1 Part 1</td>
<td></td>
<td>START Inv. 1 Part 2</td>
<td>A/W</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>START Inv. 1 Part 3</td>
<td>A</td>
<td>R/W</td>
<td>START Inv. 1 Part 4</td>
<td></td>
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<tr>
<td>3</td>
<td>Self-assess</td>
<td>A</td>
<td>R/W</td>
<td>START Inv. 2 Part 1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>START Inv. 2 Part 2</td>
<td>A</td>
<td>R/W</td>
<td>START Inv. 2 Part 4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Self-assess</td>
<td>A</td>
<td>R/W</td>
<td>START Inv. 3 Part 2</td>
<td>A/W</td>
</tr>
<tr>
<td>6</td>
<td>START Inv. 3 Part 3</td>
<td>A</td>
<td>R</td>
<td>W</td>
<td>A/</td>
</tr>
<tr>
<td>7</td>
<td>Self-assess</td>
<td>A</td>
<td>R/W</td>
<td>START Inv. 4 Part 1</td>
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<tr>
<td>8</td>
<td>START Inv. 4 Part 2</td>
<td>A</td>
<td>R/W</td>
<td>START Inv. 4 Part 4</td>
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<td>9</td>
<td>R/W</td>
<td>A</td>
<td>R</td>
<td>W</td>
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</table>

**NOTE**
The Getting Ready section for each part of an investigation helps you prepare. It provides information on scheduling the activities and introduces the tools and techniques used in the activity. Be prepared—read the Getting Ready section thoroughly.
## FOSS K–8 SCOPE AND SEQUENCE

<table>
<thead>
<tr>
<th>Grade</th>
<th>Physical Science</th>
<th>Earth Science</th>
<th>Life Science</th>
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<tr>
<td>6–8</td>
<td>Electronics</td>
<td>Planetary Science</td>
<td>Human Brain and Senses</td>
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<td>Chemical Interactions</td>
<td>Earth History</td>
<td>Populations and Ecosystems</td>
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<td></td>
<td>Force and Motion</td>
<td>Weather and Water</td>
<td>Diversity of Life</td>
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<td>4–6</td>
<td>Mixtures and Solutions</td>
<td>Weather on Earth</td>
<td>Living Systems</td>
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<td>Motion, Force, and Models</td>
<td>Sun, Moon, and Planets</td>
<td>Environments</td>
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<td>Energy and Electromagnetism</td>
<td>Soils, Rocks, and Landforms</td>
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<td>3</td>
<td>Measuring Matter</td>
<td>Water</td>
<td>Structures of Life</td>
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<td>1–2</td>
<td>Balance and Motion</td>
<td>Air and Weather</td>
<td>Insects and Plants</td>
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<td></td>
<td>Solids and Liquids</td>
<td>Pebbles, Sand, and Silt</td>
<td>Plants and Animals</td>
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<tr>
<td>K</td>
<td>Materials in Our World</td>
<td>Trees and Weather</td>
<td>Animals Two by Two</td>
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