Soils ■ Solids and Liquids ■ Comparing and Measuring ■ The Life Cycle of Butterflies ■ Ecosystems

Balancing and Weighing ■ Magnets and Motors ■ Measuring Time ■ Experiments with Plants ■ Floating and Sinking ■ Food Chemistry

Changes ■ Organisms ■ The Technology of Paper ■ Plant Growth and Development ■ Rocks and Minerals ■ Chemical Tests ■ Sound

Animal Studies ■ Land and Water ■ Electric Circuits ■ Motion and Design ■ Microworlds ■ Weather

STC™ Meets the Standards

An Analysis of the Alignment between the Science and Technology for Children™ Curriculum and the National Science Education Standards

National Science Resources Center

Smithsonian Institution ■ National Academy of Sciences
National Academy of Engineering ■ Institute of Medicine

The STC curriculum is published and distributed by Carolina Biological Supply Company

Sources of Information on the Science and Technology for Children™ Curriculum

STC™ Teacher's Guides, Student Activity Books, Student Notebooks, science materials kits, teacher-training videotapes, and Discovery Decks™ are available exclusively from the publisher, Carolina Biological Supply Company, 2700 York Road, Burlington, North Carolina 27215.

Carolina offers assistance to schools and districts seeking to evaluate or implement STC program materials. Services include providing preview and pilot-test materials, presenting professional-development workshops, and assisting with districtwide adoption and implementation of STC.

For more information, call Carolina Biological Supply Company (1-800-227-1150).

For information about the content of the STC curriculum or other NSRC activities, call the NSRC Outreach Office at 202-287-2064. The NSRC's World Wide Web address is http://www.si.edu/nsrc.

This publication was produced by NSRC staff members Carol O'Donnell, STC™ research associate, and Linda Harteker, writer/editor. Other contributors include Douglas Lapp, executive director; Patricia K. Freitag, STC project director; Dean Trackman, publications director; Kitty Lou Smith, Science and Technology Concepts for Middle Schools™ project director; Wendy Binder, STC research associate; Christopher Lyon, STC research associate; Edward Lee, STC research associate; Heidi M. Kupke, graphic designer; Max-Karl Winkler, illustrator; Matt Smith, editorial assistant; Lisa Bevell, STC program assistant; and Sylvia Carter, publications administrative assistant.

NSRC National Science Resources Center | STC™ Science & Technology for Children™

Carolina Biological Supply Company
Burlington, North Carolina 27215 1-800-334-5551

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Washington, D.C.

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STC™ Sponsors

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Additional copies of *STC™ Meets the Standards* are available from Carolina Biological Supply Company (1-800-227-1150).

How to Use This Book

The purpose of this publication is to help school administrators, curriculum coordinators, teachers, and members of curriculum adoption committees determine how the Science and Technology for Children™ (STC™) curriculum aligns with the National Science Education Standards (NSES) of the National Research Council.

Part 1 summarizes key elements of the STC learning philosophy and goals and how the curriculum was developed. It describes the components of the STC curriculum and related products. A chart sets forth the names of the 24 units and the sequence in which they are meant to be delivered. Part 1 also describes the programs of the National Science Resources Center, which developed STC.

Part 2 provides an overview of the NSES content, teaching, and assessment standards. It explains how to use the charts and narrative information in this book to identify the alignment between STC and the NSES science content standards. It also provides summary information about STC in relation to the NSES teaching and assessment standards.

Parts 3 through 8—one part each for grades 1 through 6, respectively—provide detailed, grade-by-grade information on the 24 STC units. There are four units for each grade level. Each part begins with a table highlighting the unit titles for that grade. Next, a dot matrix summarizes the NSES science content in each STC unit in that grade level. It then presents the following information on each unit for that grade:

- A one-page summary of the unit narrative, science content, and assessment strategies
- Learning goals (presented as concepts, skills, and attitudes)
- NSES science content standards covered in the unit (including the title of the standard and its conceptual organizers and fundamental principles and concepts). Because the STC units are grade-flexible, information on alignment for fourth- and fifth-grade STC units is presented under both the K–4 and 5–8 NSES categories.

Contents

PART 1

Introduction to the Science and Technology for Children™ Curriculum

Overview

The Science and Technology for Children (STC™) curriculum offers 24 units for students in grades 1 through 6. It covers four broad topic areas: life, earth, and physical sciences and technological design. The curriculum is flexible with respect to grade level; to meet specific needs, school districts may offer an STC unit one grade above or below that for which it was designed. STC is an inquiry-based curriculum. Each unit provides students with an opportunity to explore science concepts and phenomena firsthand, to reflect on their observa-tions, to share them with classmates, and to apply their learning in new situations.

Grade	Life, Earth, and Physical Sciences and Technology			
1	Organisms	Weather	Solids and Liquids	Comparing and Measuring
2	The Life Cycle of Butterflies	Soils	Changes	Balancing and Weighing
3	Plant Growth and Development	Rocks and Minerals	Chemical Tests	Sound
4	Animal Studies	Land and Water	Electric Circuits	Motion and Design
5	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
6	Experiments with Plants	Measuring Time	Magnets and Motors	The Technology of Paper

STC™ Instructional Materials

STC instructional materials include a teacher's guide, student activity books or notebooks, and science materials.

- The **teacher's guide** contains background material on science and pedagogy, guidance on science materials preparation and setup, and detailed instructions for facilitating classroom science investigations. It also contains master copies of student record sheets and other materials, suggestions for relating science to other areas of the curriculum, assessment strategies, and a bibliography.
- Reusable **student activity books,** for grades 3 through 6, contain step-by-step instructions that guide students through their classroom activities. Optional student notebooks are available for the first- and second-grade units. Since students write in these notebooks, they must be repurchased each time the unit is presented.
- Each STC kit contains the **science equipment** needed to present the unit once to a class of 30 students. Kits of expendable materials for refurbishing the classroom science materials are also available from Carolina Biological Supply Company, the STC publisher.

Carolina Biological Supply Company is now producing teacher-training videotapes to accompany the STC units. In addition, the STC student books are being translated into Spanish. Spanish editions of several units are already available.

STC Discovery Decks™

STC is developing Discovery Decks to accompany the STC units for grades 4 through 6. Discovery Decks extend the science content of the STC units. They are particularly useful in enriching learning related to the NSES categories of "Science in Personal and Social Perspectives" and of "History and Nature of Science."

Each Discovery Deck consists of approximately 32 large ($9 \times 12''$), attractively illustrated cards that elaborate on the topics introduced in the unit it accompanies. Each deck includes cards on history (for example, information on famous people and inventions), problems to solve, and connections with students' everyday world. The cards may be used in the classroom or for home projects.

For more information on the STC Discovery Decks, contact Carolina Biological Supply Company (1-800-227-1150).

STC Goals

The goals of the STC curriculum are to

- Make science relevant, interesting, and challenging for all children.
- Contribute to children's conceptual understanding of their world.
- Help children develop scientific-reasoning and problem-solving skills.
- Foster the development of scientific attitudes, such as curiosity, respect for evidence, flexibility, and sensitivity to living things.

These goals are reflected in each STC unit, where they are expressed as concepts, skills, and attitudes. Each lesson in an STC unit also contains a set of student learning objectives.

The STC™ Learning Cycle

Each STC unit is based on a four-stage learning cycle that is grounded in research on how children learn. The four steps in this cycle are Focus, Explore, Reflect, and Apply.

- First, students **focus** on what they know about a topic and what they would like to learn about it. In other words, learning begins with the student's existing knowledge and experience.
- Next, students **explore** a scientific concept or phenomenon by completing a sequence of activities. Classroom explorations are usually done in groups of two or four children.
- To reinforce learning, students **reflect** on their findings, record them in their science journals, and discuss them with their classmates.
- Finally, students **apply** their new learning to real-life situations and to other areas of the curriculum.

STC and the Development of Scientific-Reasoning Skills

The creators of the STC curriculum believe that children learn science best when the content is developmentally appropriate. For this reason, STC is structured on the basis of a sequence of scientific-reasoning skills.

This sequence begins in grade 1, where students focus on observing, measuring, and identifying properties. By grade 2, they are able to begin to recognize patterns and cycles. By grade 4, many students are able to identify cause-and-effect relationships. Finally, by grade 6, students can design and conduct their own controlled experiments. As they progress through this sequence, students not only gain an understanding of science concepts and phenomena but also develop critical-thinking skills.

Development and Distribution of the STC Curriculum

STC was developed by the National Science Resources Center (NSRC), a nonprofit organization jointly operated by the Smithsonian Institution and the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. The NSRC's offices are in Washington, D.C.

Each STC unit was written by a teacher-developer working in collaboration with educators, scientists, and evaluators, as well as with science editors and illustrators. All units were pilot-tested in elementary schools in the Washington, D.C., metropolitan area and field-tested in demographically diverse classrooms throughout the United States. Input from teachers and students who participated in the field tests, as well as recommendations provided by an independent evaluator, were incorporated into the final version of the text.

STC is published exclusively by Carolina Biological Supply Company, Burlington, North Carolina. Carolina, the nation's largest distributor of classroom science materials, is the only company that distributes STC science kit materials that have been reviewed and approved by the NSRC.

Other NSRC Activities and Programs

In 1997, the National Science Resources Center received a grant from the National Science Foundation to produce a new curriculum, Science and Technology Concepts for Middle Schools™ (STC/MS™), which will complement STC™. It will contain eight modules that will focus on topics related to the life, earth, and physical sciences and technological design. Two professional-development modules for teachers will also be developed.

In addition to developing science curricula, the NSRC publishes books and other documents of interest to science educators. Among the NSRC's most recent publications are *Science for All Children: A Guide to Improving Elementary Science Education in Your School District* and *Resources for Teaching Elementary School Science*, both of which were published by the National Academy Press. Slated for publication in early 1998 is *Resources for Teaching Middle School Science.*

A third area of NSRC activity is leadership training. The NSRC conducts leadership institutes at the national and regional levels to prepare teams of science teachers, school administrators, and scientists, engineers, and business leaders to organize science education reform efforts in their communities. The NSRC is funded through grants from government agencies, corporations, and philanthropic foundations.

PART 2

STC™ and the National Science Education Standards

Introduction

The National Science Education Standards, published by the National Research Council in 1996, call for a new vision of science literacy for all students. The standards are not prescriptive; rather, they set forth criteria that each school district can use as a basis for designing a science program that best meets the needs of its students. These criteria cover six areas: science content, teaching methods, professional development, assessment, program design, and science systems.

This publication analyzes the STC curriculum in light of three NSES criteria—science content, teaching methods, and assessment. This chapter provides a brief introduction to the standards in these three areas.

NSES Science Content Standards

Content standards are the heart of a science program. They describe what students should understand and be able to do in science from kindergarten through their senior year in high school.

Each NSES content standard has four parts: a title, a stem, a list of conceptual organizers, and a series of fundamental concepts and principles.

- The **title** is the category of the standard. There are eight science content standards: unifying concepts and processes in science; science as inquiry; physical science; life science; earth and space science; science and technology; science in personal and social perspectives; and history and nature of science.
- The **stem** is an introductory phrase that stipulates grade span (that is, K–4, 5–8, or 9–12) and learning outcome (for example, "understanding").
- The **conceptual organizers** are comparable to lesson or unit topics. Under the title "Physical Science" in the K–4 grade span, for example, the conceptual organizers include "properties of objects and materials," "position and motion of objects," and "magnetism." By grades 9–12, the conceptual organizers under the same title are more complex and include "structure of atoms," "chemical reactions," and "interactions of energy and matter."
- The **fundamental concepts and principles** are the scientific principles or concepts that support the conceptual organizers. They appear in the NSES publication in paragraph form. Each concept is placed under the appropriate conceptual organizer.

STC™ and the NSES Content Standards

This publication uses two ways of showing how the STC units align with the standards: dot matrixes and narrative lists entitled "Fundamental Concepts and Principles Addressed."

Dot Matrixes

Two comprehensive dot matrixes appear on pages 14 to 16. In addition, grade-specific matrixes appear at the beginning of each chapter (see, for example, page 18). Two matrixes are provided for the fourth- and fifth-grade units; one matrix shows alignment with K–4 standards, and the other shows alignment with 5–8 standards.

On the matrixes, the NSES **title** category appears in gray and the **conceptual organizers** appear directly below it. A dot in the column under the STC unit title indicates that the conceptual organizer is addressed in one or more of the lessons or reading selections of that unit.

Fundamental Concepts and Principles Addressed

The pages entitled "Fundamental Concepts and Principles Addressed (K–4 or 5–8)" provide more detailed information than the dot matrixes (see, for example, page 21). On these pages, the NSES category title appears as a bold head. The **conceptual organizers** are subheads and appear in italics. The **fundamental principles** appear as bulleted items. In some cases, the original language has been shortened or paraphrased; only language that is applicable to the unit has been included. Each fourth- and fifth-grade unit is analyzed in relation both to the K–4 standards and the 5–8 standards.

STC's Grade-Level Flexibility

The writers of the NSES wanted science learning to be flexible. Learning outcomes are, therefore, set forth by grade span (that is, K–4, 5–8, and 9–12) rather than by grade level. Within each of these sequences, the science content may be presented at the grade level that a school district believes is most appropriate.

Like the standards, the STC curriculum is designed to provide maximum flexibility in grade levels. While each unit is designated for use at a particular grade level, it may be used at the level below or above the designated grade. Thus, depending on the overall science program or the abilities of students, *The Life Cycle of Butterflies,* developed for grade 2, may also be taught successfully at grade 1 or 3. It is helpful to think of each level of STC units as a band that crosses three grade levels.

This flexibility becomes critical at the interface of grades 4 and 5, which cross the NSES grade spans. For this reason, the information in this publication shows how grade 4 STC units align with 5–8, as well as K–4, content standards. To complete the picture, information on grade 5 units shows how these units align with K–4, as well as 5–8, standards. For example:

- The 5–8 earth science concept on the water cycle states that water "falls to earth where it collects in lakes, oceans, soil, and in rocks underground." This concept expands on the K–4 NSES physical science concept "water can change from one state to another." Both concepts, however, are covered in the fourth-grade STC earth science unit *Land and Water.*
- The fifth-grade STC unit *Food Chemistry* addresses both the K–4 NSES personal health principle "students should understand how the body uses food and how various foods contribute to health," as well as the 5–8 concept, "food provides energy and nutrients for growth and development."

By examining how the fourth- and fifth-grade units align with both the K–4 and 5–8 standards, districts may make appropriate decisions about where to place the unit in their curriculum. For example, many districts use *Land and Water,* designated as a fourth-grade unit, in grade 5. At the same time, districts may use the fifth-grade unit *Floating and Sinking* in grade 4.

NSES Teaching Standards

The six NSES science teaching standards describe the actions teachers must take and the knowledge and skills they need in order to plan for, facilitate, and assess student learning. They focus on the following areas:

- Tailoring learning opportunities to student needs.
- Facilitating inquiry.
- Assessing student learning on an ongoing basis.
- Creating an environment that provides the resources and atmosphere needed for science learning.
- Encouraging collaboration, respect for diverse ideas, and other values that are consistent with scientific inquiry.
- Working with peers to plan the overall science program.

STC™ and the NSES Teaching Standards

Successful implementation of the STC curriculum in the classroom and adherence to the NSES teaching standards go hand in glove. Unless a teacher adheres to these standards, he or she cannot facilitate learning in an STC classroom, as illustrated by the following examples.

In an STC classroom, the teacher . . .

- **Selects and adapts the curriculum** instead of using a "one size fits all" approach. During class brainstorming sessions, generally held at the beginning of each new unit or learning activity, students share what they already know about a new topic and what they would like to know. Teachers use this information as a basis for tailoring learning activities as well as for post-unit assessments of student learning.
- **Focuses on helping students ask questions, test ideas, and draw conclusions** on the basis of evidence instead of focusing on acquiring factual information.
- **Facilitates discussion and hands-on investigation** instead of presenting knowledge through lectures or teacher demonstrations.
- **Builds students' skills in cooperative learning and respect for the ideas of others** as they explore science phenomena with lab partners and in small groups.
- **Helps students build links between science and the real world and between science and other areas of the elementary curriculum** through the use of extensions, bibliographies, and other supplementary material.
- **Continually assesses student understanding** through observing students' daily activities and examining journals, record sheets, and performance-based assessments instead of testing students for factual information at the end of a unit.

NSES Assessment Standards

New ways of teaching and learning science demand new approaches to assessing student progress. In this new approach, learning and assessing are closely related. Assessments provide much more than a benchmark for student progress; they are the primary feedback mechanism in the science education system. To emphasize the key role of assessment, the NSES contain five criteria against which districts can judge the quality of their assessment strategies:

- The consistency of assessments with the decisions they are designed to inform.
- The assessment of achievement and opportunity to learn science.
- Matching the quality of data collected and the consequences of actions taken on the basis of those data.
- Fairness.
- The soundness of inferences made from the assessments.

STC™ and the NSES Assessment Standards

Assessment is a particular strength of the STC curriculum. In fact, all STC assessment activities have been professionally evaluated by researchers from the Program Evaluation and Research Group at Lesley College, Cambridge, Massachusetts. STC assessments are consistent with the NSES standards in that they are deliberately designed to focus on the science content and skills that are most important for students to learn. Their purpose is to determine students' scientific-reasoning skills as well as their understanding of science concepts. Because of their variety, the STC assessments offer opportunities for all students to demonstrate their strengths.

STC assessment strategies include

- Matched pre- and post-unit assessments that enable teachers to evaluate student growth.
- Embedded assessments that occur naturally within a unit and make assessment seamless with learning.
- Additional assessments (also called final assessments) at the end of the unit that offer a variety of opportunities to evaluate student progress. Some are performance-based assessments that challenge students to use their science materials to solve new problems. Others include teacher review of student work products, oral presentations, and paper-and-pencil tests.
- Student self-assessments that allow students and teachers to track progress.

STC™ Units and K–4 Science Content Standards Matrix

Developed for Grades	1	1	1	1	2	2	2	2	3	3	3	3
Unit Titles	Organisms	Weather	Solids and Liquids	Comparing and Measuring	The Life Cycle of Butterflies	Soils	Changes	Balancing and Weighing	Plant Growth and Development	Rocks and Minerals	Chemical Tests	Sound
Science as Inquiry												
Abilities necessary to do scientific inquiry	●	●	●	●	●	●	●	●	●	●	●	●
Understandings about scientific inquiry	●	●	●	●	●	●	●	●	●	●	●	●
Physical Science												
Properties of objects and materials		●	●	●		●	●	●		●	●	●
Position and motion of objects			●	●				●				●
Light, heat, electricity, and magnetism			●				●			●	●	
Life Science												
Characteristics of organisms	●				●	●			●			●
Life cycles of organisms	●				●				●			
Organisms and environments	●		●		●	●			●			●
Earth and Space Science												
Properties of earth materials			●			●	●		●	●	●	
Objects in the sky		●										
Changes in earth and sky		●	●				●			●		
Science and Technology												
Abilities of technological design				●		●	●	●	●			●
Understandings about science and technology	●	●	●	●	●	●	●	●	●	●	●	●
Abilities to distinguish between natural objects and objects made by humans	●	●							●	●	●	
Science in Personal and Social Perspectives												
Personal health		●	●		●		●				●	●
Characteristics and changes in populations												
Types of resources	●				●					●	●	
Changes in environments	●		●		●					●		
Science and technology in local challenges		●	●					●	●			●
History and Nature of Science												
Science as a human endeavor	●	●	●	●	●	●	●	●	●	●	●	●
Unifying Concepts and Processes												
Systems, order, and organization	●	●	●	●		●	●	●	●	●	●	●
Evidence, models, and explanation	●	●	●	●	●	●	●	●	●	●	●	●
Constancy, change, and measurement	●	●	●	●	●	●	●	●	●	●	●	●
Evolution and equilibrium								●		●		
Form and function	●		●	●	●	●		●	●	●		●

Developed for Grades	4	4	4	4	5	5	5	5
Unit Titles	Animal Studies	Land and Water	Electric Circuits	Motion and Design	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
Science as Inquiry								
Abilities necessary to do scientific inquiry	●	●	●	●	●	●	●	●
Understandings about scientific inquiry	●	●	●	●	●	●	●	●
Physical Science								
Properties of objects and materials		●	●	●	●	●	●	●
Position and motion of objects		●		●				●
Light, heat, electricity, and magnetism			●		●			
Life Science								
Characteristics of organisms	●				●	●	●	
Life cycles of organisms	●				●	●		
Organisms and environments	●	●				●		
Earth and Space Science								
Properties of earth materials		●				●		
Objects in the sky								
Changes in earth and sky		●						
Science and Technology								
Abilities of technological design	●	●	●	●		●		●
Understandings about science and technology	●	●	●	●	●	●	●	●
Abilities to distinguish between natural objects and objects made by humans	●	●			●	●	●	
Science in Personal and Social Perspectives								
Personal health			●				●	●
Characteristics and changes in populations								
Types of resources	●	●	●			●	●	
Changes in environments	●	●				●		
Science and technology in local challenges		●	●	●	●	●	●	●
History and Nature of Science								
Science as a human endeavor	●	●	●	●	●	●	●	●
Unifying Concepts and Processes								
Systems, order, and organization	●	●	●	●	●	●	●	●
Evidence, models, and explanation	●	●	●	●	●	●	●	●
Constancy, change, and measurement	●	●	●	●		●	●	●
Evolution and equilibrium	●	●		●		●		●
Form and function	●	●	●	●	●	●	●	●

STC™ Units and 5–8 Science Content Standards Matrix

Developed for Grades	4	4	4	4	5	5	5	5	6	6	6	6
Unit Titles	Animal Studies	Land and Water	Electric Circuits	Motion and Design	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking	Experiments with Plants	Measuring Time	Magnets and Motors	The Technology of Paper
Science as Inquiry												
Abilities necessary to do scientific inquiry	●	●	●	●	●	●	●	●	●	●	●	●
Understandings about scientific inquiry	●	●	●	●	●	●	●	●	●	●	●	●
Physical Science												
Properties and changes of properties in matter		●	●				●	●			●	●
Motions and forces		●		●				●		●	●	
Transfer of energy			●	●	●					●	●	
Life Science												
Structure and function in living systems	●				●	●			●			
Reproduction and heredity	●				●	●			●			
Regulation and behavior	●	●			●	●			●		●	
Populations and ecosystems						●						
Diversity and adaptations of organisms	●				●				●			
Earth and Space Science												
Structure of the earth system		●				●						
Earth's history		●										
Earth in the solar system		●							●	●		
Science and Technology												
Abilities of technological design	●	●	●	●				●		●	●	●
Understandings about science and technology	●	●	●	●	●	●	●	●		●	●	●
Science in Personal and Social Perspectives												
Personal health	●		●			●	●	●			●	
Populations, resources, and environments		●				●						
Natural hazards		●				●						●
Risks and benefits		●				●	●					
Science and technology in society	●	●	●	●	●	●	●	●		●	●	●
History and Nature of Science												
Science as a human endeavor	●	●	●	●	●	●	●	●	●	●	●	●
Nature of science	●	●	●	●	●	●	●	●	●	●	●	●
History of science		●	●	●	●		●	●	●	●	●	●
Unifying Concepts and Processes												
Systems, order, and organization	●	●	●	●	●	●	●	●	●	●	●	
Evidence, models, and explanation	●	●	●	●	●	●	●	●	●	●	●	●
Constancy, change, and measurement	●	●	●	●		●	●	●	●	●	●	●
Evolution and equilibrium	●	●		●		●		●				
Form and function	●	●	●	●	●	●	●	●	●	●	●	●

PART 3

Science and Technology for Children™

FIRST-GRADE UNITS

Grade	Life, Earth, and Physical Sciences and Technology			
1	**Organisms**	**Weather**	**Solids and Liquids**	**Comparing and Measuring**
2	The Life Cycle of Butterflies	Soils	Changes	Balancing and Weighing
3	Plant Growth and Development	Rocks and Minerals	Chemical Tests	Sound
4	Animal Studies	Land and Water	Electric Circuits	Motion and Design
5	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
6	Experiments with Plants	Measuring Time	Magnets and Motors	The Technology of Paper

First-Grade STC™ Units and the NSES (K–4)

National Science Education Standards for Grades K–4	Organisms	Weather	Solids and Liquids	Comparing and Measuring
Science as Inquiry				
Abilities necessary to do scientific inquiry	●	●	●	●
Understandings about scientific inquiry	●	●	●	●
Physical Science				
Properties of objects and materials		●	●	●
Position and motion of objects			●	●
Light, heat, electricity, and magnetism			●	
Life Science				
Characteristics of organisms	●			
Life cycles of organisms	●			
Organisms and environments	●		●	
Earth and Space Science				
Properties of earth materials			●	
Objects in the sky		●		
Changes in earth and sky		●	●	
Science and Technology				
Abilities of technological design				●
Understandings about science and technology	●	●	●	●
Abilities to distinguish between natural objects and objects made by humans	●	●		
Science in Personal and Social Perspectives				
Personal health		●	●	
Characteristics and changes in populations				
Types of resources	●			
Changes in environments	●		●	
Science and technology in local challenges		●	●	
History and Nature of Science				
Science as a human endeavor	●	●	●	●
Unifying Concepts and Processes				
Systems, order, and organization	●	●	●	●
Evidence, models, and explanation	●	●	●	●
Constancy, change, and measurement	●	●	●	●
Evolution and equilibrium				
Form and function	●		●	●

Organisms

Narrative Summary

This unit provides hands-on experiences that help students develop an understanding of and sensitivity to living things. Students create and maintain a woodland habitat containing pine seedlings, moss, pill bugs, and Bess beetles or millipedes. They also set up and observe a freshwater habitat into which they introduce elodea and cabomba plants, pond snails, and guppies. With both plants and animals in each habitat, students have the opportunity to observe how these organisms coexist. Through studying the needs and characteristics of a variety of organisms, the students are able to draw conclusions about how plants and animals are similar and different. In a final lesson, students apply to humans what they have learned about organisms, exploring how human beings are similar to and different from other living things.

Science Content

In this unit, students observe and compare living things to identify their characteristics and resource needs. Students are encouraged to use their own observations to support their ideas about the similarities and differences between plants and animals. The diversity of living things is introduced through readings about interesting and exotic plants and animals. Students explore life cycles through their own observations and questions.

Assessment

In a matched pre- and post-unit assessment, each student draws a living thing and writes about what it needs to live and be healthy. Students also share what they know and want to know about plants and animals and how they are alike and different. Through this matched assessment, students are likely to appreciate how much they have learned about the needs of living things. Throughout the unit, students maintain journals in which they record their observations of a plant they grow from a seed. Class stories, which describe how seeds grow, and planting cards, which serve as laboratory notebooks, allow for assessment of students' daily observations. Record sheets track development of students' ideas about their classroom organisms. Teachers can use learning goals and progress charts provided to evaluate student progress and communicate that progress to parents. Additional assessments at the close of the unit include suggestions on assessing student work samples, setting up student meetings, and inviting students to make presentations that assess concepts, skills, and attitudes developed throughout the unit.

Goals for *Organisms*

In this unit, students explore the similarities and differences between plants and animals. Through their experiences, students are introduced to the following concepts, skills, and attitudes.

Concepts

- We use our senses to observe the world around us.
- Organisms have basic needs, such as food, water, air, space, and shelter.
- Each type of organism has specific needs, such as type of food, amount of water, amount of light, amount of space, and type of shelter.
- There is a wide diversity of living things on earth.
- Organisms grow, change, and die over time.
- Some plants grow from seeds. The roots grow first and then the stem.
- Plants have similarities, such as the ability to grow and the need for water, light, space, and air.
- Animals have similarities, such as the ability to move and the need for food, water, space, and shelter.
- Plants and animals have similarities, such as basic needs, ability to grow and change, and death.
- Humans are similar to other organisms. Humans have basic needs and also grow, change, and die.

Skills

- Observing and describing the characteristics of seeds and plants.
- Planting seeds and observing and recording their growth.
- Observing and describing the characteristics of a variety of plants and animals in woodland and freshwater environments.
- Recording observations in words and drawings.
- Making comparisons among a variety of plants and animals.
- Communicating ideas through writing, drawing, and discussion.
- Reading to enhance understanding of the basic needs of organisms and the diversity of life.
- Applying what students know about plants and animals to what students know about themselves.
- Maintaining plants and animals outside their natural environments.

Attitudes

- Developing an interest in exploring the characteristics of plants and animals.
- Gaining an awareness of the diversity of life.
- Developing positive attitudes toward different forms of life.
- Developing an awareness that humans are similar to other living things.
- Developing a sensitivity to the needs of living things.

Organisms

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers and rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Life Science

Characteristics of organisms

- Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light. Organisms can survive only in environments in which their needs can be met. The world has many different environments, and distinct environments support the life of different types of organisms.
- Each plant or animal has different structures that serve different functions in growth and survival. For example, humans have distinct body structures for walking, holding, seeing, and talking.

Life cycles of organisms

- Plants and animals have life cycles that include being born, developing into adults, reproducing, and eventually dying. The details of this life cycle are different for different organisms.
- Animals closely resemble their parents.

Organisms and their environments

- All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.
- An organism's patterns of behavior are related to the nature of that organism's environment, including the kinds and number of other organisms present, the availability of food and resources, and the physical characteristics of the environment.
- All organisms cause changes in the environment where they live. Some of these changes are detrimental to the organism or the organisms, whereas others are beneficial.
- Humans depend on their natural or constructed environments.

Science and Technology

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Tools help scientists make better observations and measurements. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Abilities to distinguish between natural objects and objects made by humans

- Some objects occur in nature; others have been designed and made by humans.

Science in Personal and Social Perspectives

Types of resources

- Air, water, and soil are basic resources.

Changes in environments

- Environments are the space, conditions, and factors that affect an individual's ability to survive.

History and Nature of Science

Science as a human endeavor

- Many people choose science as a career. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Form and function

Weather

Narrative Summary

This unit introduces first-graders to the concept of weather and how it affects their lives. Using a variety of tools, students observe, discuss, measure, and record data on cloud cover, precipitation, wind, and temperature. They learn how to read a thermometer and construct a rain gauge to measure precipitation. They also study cloud formations and use a wind scale to estimate the speed of wind. To apply their new skills and knowledge, students compare their own weather predictions with an actual weather forecast and use the weather data they have collected to form generalizations about the weather in their own locale.

Science Content

Throughout this unit, students use science tools to extend their senses. Students engage in scientific inquiry by setting up several simple investigations on the effect color has on temperature and heat absorption. Math skills are used in context when students apply a scale to their measurements and create graphs. Long-term data collection is emphasized when students take responsibility for collecting data, recording it in a class weather calendar, and making reports to their classmates. Students use data to look for patterns and learn to make predictions. Reading selections extend the unit's content by addressing the career of meteorology and the history and invention of the umbrella and mackintosh raincoat.

Assessment

In Lesson 1, students observe the day's weather and then discuss how they might use this information to decide what they will wear to school. A class graph serves as a means of organizing information about students' favorite types of weather. This pre-unit assessment, matched to a post-unit assessment following Lesson 16, serves as a basis for assessing students' growth in knowledge. Throughout the unit, assessments are incorporated, or embedded, into the lessons. Lesson 8, which serves as an embedded assessment, asks students to apply what they have learned about temperature to a new situation. By measuring the temperatures of hot, cold, and mixed hot and cold water, students demonstrate growth in learning to read and record temperature. At the close of the unit, students make sense of their data on wind speed, cloud cover, precipitation, and temperature by comparing their weather predictions with those of a meteorologist. Additional assessments at the end of the unit include developing and presenting student-made weather reports, drawing pictures of different types of weather, and presenting weather information to visitors. Students can also revisit a temperature activity from earlier in the unit.

Goals for *Weather*

In this unit, students' observations and activities expand their awareness of weather, its features, and its effects on their daily lives. Their experiences introduce them to the following concepts, skills, and attitudes.

Concepts

- Weather changes from day to day and week to week.
- Features of weather include cloud cover, precipitation, wind, and temperature.
- Tools used to measure different features of weather include wind scales, thermometers, and rain gauges.
- Meteorologists are scientists who study, observe, and record information about the weather and who use that information to forecast the weather.
- Weather affects the decisions people make about the clothing they will wear and about their outside activities.

Skills

- Observing the weather by using the senses.
- Discussing and recording information about weather features.
- Using simple tools to estimate wind speed and measure temperature and rainfall.
- Observing differences in types of clouds.
- Conducting experiments and drawing conclusions about appropriate clothing for different types of weather.
- Organizing weather data on graphs and long-term data collection charts.
- Interpreting and summarizing long-term weather data.

Attitudes

- Increasing awareness of weather.
- Appreciating how weather affects daily life.
- Recognizing that measurements and long-term records are useful and help us learn more about weather.

Weather

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer to what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer. Types of investigations include describing events, classifying them, and doing a fair test (experimenting).
- Simple instruments, such as magnifiers and thermometers, provide more information than scientists obtain using only their senses.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, shape, color, and temperature. These properties can be measured using tools, such as thermometers.
- Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects.
- Materials can exist in different states—solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another.

Earth and Space Science

Objects in the sky

- The sun, moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described.
- The sun provides the light and heat necessary to maintain the temperature of the earth.

Changes in the earth and sky

- Weather changes from day to day and over the seasons. Weather can be described by measurable quantities, such as temperature, wind direction and speed, and precipitation.
- Objects in the sky have patterns of movement.

Science and Technology

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things they could not otherwise see, measure, and do.

Abilities to distinguish between natural objects and objects made by humans

- Objects can be categorized into two groups, natural and designed.

Science in Personal and Social Perspectives

Personal health

- Safety and security are basic needs of humans. Safety involves freedom from danger, risk, or injury. Student understandings include following safety rules.

Science and technology in local challenges

- People continue inventing new ways of doing things, solving problems, and getting work done. New ideas and inventions often affect other people.

History and Nature of Science

Science as a human endeavor

- Science and technology have been practiced by people for a long time.
- Men and women have made a variety of contributions throughout the history of science and technology.
- Many people choose science as a career. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Solids and Liquids

Narrative Summary

In this unit, students investigate the similarities and differences in a variety of common solids and liquids. First, they observe, describe, and compare a collection of solid objects, focusing on such properties as color, shape, texture, and hardness. They also perform tests to determine whether the objects roll or stack and float or sink, as well as whether they are attracted to a magnet. Investigations of liquids center on how various liquids look and feel, their fluidity, how they mix with water, and their degree of absorption. In a final lesson, students compare the properties of solids and liquids and identify how they are similar and different.

Science Content

Solids and liquids have observable properties that can be described and compared. Some properties of solids and liquids are shape, color, texture, miscibility, and fluidity or viscosity. These properties can be used to sort the solids and liquids studied in the classroom and to investigate new materials. Physical science concepts studied include motion, magnetism, and buoyancy as they relate to solids and liquids. Reading selections in the unit address pollutants, weather, and rocks.

Assessment

In Lesson 1, students are asked to observe, describe, and compare two solids—a spoon and a steel ball. Students' oral descriptions of these objects and a written description of what they know about solids provide a pre-unit assessment of their skills in observing and describing the properties of solids. Lesson 10 serves as a pre-assessment for the second half of the unit, in which students observe and describe the properties of liquids. Following Lesson 16 is a post-unit assessment that is matched to Lessons 1 and 10 and helps determine students' growth in concepts and skills throughout the unit. An activity called "guess my reason" helps in assessing students' observational skills. This opens up the possibility of many "right" answers. Embedded assessments in Lessons 9 and 15 challenge students to apply what they have learned in the unit as they conduct tests to learn more about two new solids and liquids. Additional assessments at the end of the unit include an investigation in which students mix cornstarch and water, suggestions for helping students share what they have learned with visitors, and strategies for reviewing student work.

Goals for *Solids and Liquids*

In this unit, students expand their awareness of the properties of solids and liquids. Their experiences introduce them to the following concepts, skills, and attitudes.

Concepts

- Solids and liquids can be described by their properties.
- Some properties of solids are color, shape, ability to roll or stack, hardness, magnetic attraction, and whether they float or sink.
- Some properties of liquids are color, tendency to flow, degree of viscosity or fluidity, whether they are miscible with water, and whether they float or sink in water.
- Tests can be performed to investigate properties of solids and liquids that cannot otherwise be observed.

Skills

- Observing and describing the properties of solids and liquids.
- Conducting tests to investigate the properties of solids and liquids.
- Sorting solids into groups on the basis of their properties.
- Comparing similarities and differences among solids.
- Comparing similarities and differences among liquids.
- Applying tests to investigate new solids and liquids.
- Comparing the properties of solids with the properties of liquids.
- Communicating ideas, observations, and experiences through writing, drawing, and discussion.

Attitudes

- Accepting that there is more than one way to describe solids and liquids.
- Recognizing the importance of organizing information and results on charts.
- Developing an interest in investigating the physical world.

Solids and Liquids

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigations public; they describe the investigations in ways that enable others to repeat the investigations.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, weight, shape, and color.
- Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.
- Materials can exist in different states.

Position and motion of objects

- The position of an object can be described by locating it relative to another object or the background.
- An object's motion can be described by tracing its position over time.
- The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.

Light, heat, electricity, and magnetism

- Magnets attract and repel each other and certain kinds of materials.

Life Science

Organisms and their environments

- When an organism's environment changes, some plants and animals survive and reproduce, and others die or move.
- Humans change environments in ways that can either be beneficial or detrimental for themselves and other organisms.

Earth and Space Science

Properties of earth materials

- Earth materials include solid rocks. These materials have different physical properties that make them useful in different ways.

Changes in the earth and sky

- Weather changes from day to day and over the seasons.

Science and Technology

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- Scientists and engineers often work in teams with different things that contribute to the results.

- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations, measurements, and equipment for investigations.

Science in Personal and Social Perspectives

Personal health

- Safety and security are basic needs of humans. Safety involves freedom from risk or danger.

Changes in environments

- Changes in environments can be natural or influenced by humans. Some changes are good, some are bad, and some are neither good nor bad. Pollution is a change in the environment that can influence the health, survival, and activities of organisms, including humans.

Science and technology in local challenges

- People are inventing new ways of doing things, solving problems, and getting work done.

History and Nature of Science

Science as a human endeavor

- Men and women have made a variety of contributions throughout the history of science.
- Many people choose science as a career. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Form and function

Comparing and Measuring

Narrative Summary

In this unit, students explore the concepts that underlie the science skills of comparing and measuring. The lessons are based on a developmental sequence that includes three activities: comparing, matching, and measuring. Initially, students compare lengths by matching measuring tape to their own heights and the lengths of their arms and legs. They make the transition from matching to measuring length by quantifying nonstandard units of measure (in this case, their own feet) and discover that using nonstandard units of measure produces varied results. Finally, students use standard units of measure, such as Unifix Cubes® and measuring strips, to measure height, width, and distance. In so doing, students begin to understand key measuring concepts, such as using beginning and ending points, a common starting line, and standard units of measure.

Science Content

This unit emphasizes observation, description, and relative measurement. It also introduces standard units. Students use their own height and the size of various parts of their bodies to explore measurement concepts and develop systems for comparison. By comparing body cutouts, students develop an awareness of themselves and others. Students are introduced to simple measuring tools and units. This unit connects easily with technology, mathematics, measurement, and graphing. It prepares students for the introduction of formal measuring, as well as the use of standardized units commonly used in science.

Assessment

Lesson 1 of this unit begins as students discuss what it means to compare and measure. This pre-unit assessment provides insight into students' knowledge of the kinds of comparisons they make in their lives and the methods they use to make them. In an embedded assessment, students have the opportunity to apply their understanding of measurement and make comparisons by selecting the appropriate unit of measurement, measuring accurately, and stating reasonable comparisons. This provides the opportunity to assess the comparing, matching, and measuring skills that students have gained during the unit. Following Lesson 16, a post-unit assessment is matched to the pre-unit assessment in Lesson 1. Additional assessments, such as the task of wrapping a gift, offer students further challenges in comparing, matching, and measuring.

Goals for *Comparing and Measuring*

In this unit, students' observations and activities expand their awareness of comparing and measuring. From their experiences, they are introduced to the following concepts, skills, and attitudes.

Concepts

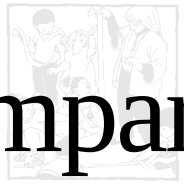
- Comparing involves observing similarities and differences.
- One way to make comparisons is by matching.
- Using beginning and ending points and placing units end to end are important factors when measuring.
- Nonstandard units of measure produce varying results.
- Standard units of measure produce more consistent results than nonstandard units and make it possible to share information.
- Different units and tools can be used to measure objects.
- Long tools make it easier to measure long objects.
- A common starting line is required to make fair comparisons.

Skills

- Observing similarities and differences among objects.
- Describing similarities and differences among objects.
- Placing objects in serial order on the basis of height or length.
- Communicating observations, ideas, and questions through discussion, drawing, and writing.
- Organizing information on representational graphs and charts.
- Making predictions about the relative lengths and sizes of objects.
- Using standard and nonstandard units of measure.
- Using groups of tens to quantify large numbers of units.
- Measuring using beginning and ending points.
- Interpreting results of measurements.

Attitudes

- Developing an awareness of self and others by comparing height, length of arms and legs, and body cutouts.
- Developing an appreciation of the usefulness of measuring in our daily lives.
- Becoming comfortable using a variety of measuring tools and units of measure.
- Recognizing the importance of developing strategies for counting large numbers.
- Appreciating the importance of organizing information on graphs and charts.



Comparing and Measuring

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, such as rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size and shape, and can be measured using tools, such as rulers.
- Properties can be used to separate or sort a group of objects.

Position and motion of objects

- The position of an object can be described by locating it relative to another object or the background.
- An object's motion can be described by tracing and measuring its position over time.
- The position and motion of an object can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Communicate a problem, design, and solution.

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering and explaining questions about the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations, measurements, and equipment for investigation.

History and Nature of Science

Science as a human endeavor

- Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Form and function

PART 4

Science and Technology for Children™

SECOND-GRADE UNITS

Grade	Life, Earth, and Physical Sciences and Technology			
1	Organisms	Weather	Solids and Liquids	Comparing and Measuring
2	**The Life Cycle of Butterflies**	**Soils**	**Changes**	**Balancing and Weighing**
3	Plant Growth and Development	Rocks and Minerals	Chemical Tests	Sound
4	Animal Studies	Land and Water	Electric Circuits	Motion and Design
5	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
6	Experiments with Plants	Measuring Time	Magnets and Motors	The Technology of Paper

Second-Grade STC™ Units and the NSES (K–4)

National Science Education Standards for Grades K–4	The Life Cycle of Butterflies	Soils	Changes	Balancing and Weighing
Science as Inquiry				
Abilities necessary to do scientific inquiry	●	●	●	●
Understandings about scientific inquiry	●	●	●	●
Physical Science				
Properties of objects and materials		●	●	●
Position and motion of objects				●
Light, heat, electricity, and magnetism			●	
Life Science				
Characteristics of organisms	●	●		
Life cycles of organisms	●			
Organisms and environments	●	●		
Earth and Space Science				
Properties of earth materials		●	●	
Objects in the sky				
Changes in earth and sky			●	
Science and Technology				
Abilities of technological design		●	●	●
Understandings about science and technology	●	●	●	●
Abilities to distinguish between natural objects and objects made by humans				
Science in Personal and Social Perspectives				
Personal health	●		●	
Characteristics and changes in populations				
Types of resources	●			
Changes in environments	●			
Science and technology in local challenges				●
History and Nature of Science				
Science as a human endeavor	●	●	●	●
Unifying Concepts and Processes				
Systems, order, and organization		●	●	●
Evidence, models, and explanation	●	●	●	●
Constancy, change, and measurement	●	●	●	●
Evolution and equilibrium				●
Form and function	●	●		●

The Life Cycle of Butterflies

Narrative Summary

This unit introduces students to the concept of life cycles by inviting them to investigate one organism—the Painted Lady butterfly *(Vanessa cardui).* During an eight-week period, students observe, record, and describe the metamorphosis from caterpillar to chrysalis and from chrysalis to butterfly. In many cases, they watch the butterfly lay eggs. The butterfly ultimately dies a natural death, thereby completing students' observations of the life cycle. The children compare the life cycle of the butterfly with that of other organisms, an experience that deepens their understanding of the diversity of life and the patterns that characterize animal life cycles.

Science Content

Characteristics of organisms, the life cycle, and organisms in their environment are the focus of this unit. Resource needs for food and habitat are introduced as students observe the stages in the life of the Painted Lady butterfly. As the butterfly emerges, students observe the process, identify the butterfly body parts, and learn how the body parts function. Students focus on, explore, reflect on, and communicate about butterflies and their transformations during their life cycle. Throughout the unit, emphasis is placed on developing observational and recording skills. Read-aloud stories about the discovery and history of silk add to the content of this unit.

Assessment

In a pre-unit assessment, students share their prior knowledge of caterpillars and then draw what they think a caterpillar looks like and how it changes during its life. Matched post-unit assessments give teachers evidence of growth in students' understanding of life cycles, observation skills, and ability to engage in cooperative learning. Throughout the unit, students' drawings and shared observations can be used to assess their observational skills and understanding of life cycles. Midway through the unit, students are asked to reflect on their own progress and to apply their knowledge of the butterfly's life cycle to life cycles of other organisms. Additional assessments at the end of the unit allow teachers to compare student drawings with similar illustrations done in Lesson 1 and to write a story about the butterfly's life. A teacher's record chart of student progress provides teachers with another method for assessing student products, learning goals, and general skills used in the unit.

Goals for The Life Cycle of Butterflies

In this unit, students observe the life cycle of the Painted Lady butterfly. Through their experiences, they are introduced to the following concepts, skills, and attitudes.

Concepts

- The different stages of a butterfly's life cycle are egg, larva, caterpillar, chrysalis, and adult.
- Caterpillars need food, air, and space to live and grow.
- The caterpillar forms a chrysalis, and a butterfly emerges from the chrysalis.
- A butterfly needs food to live, but it does not grow after emerging from the chrysalis.
- A butterfly lays eggs, which hatch into larvae.

Skills

- Observing, describing, and recording growth and change in the larva.
- Predicting, comparing, and discussing the larva's appearance and change over time.
- Communicating observations through drawing and writing.
- Relating observations of the butterfly's life cycle to students' own growth and change.
- Extending knowledge of butterflies through reading.

Attitudes

- Developing an interest in studying insects.
- Appreciating the needs of living things.
- Valuing scientific information that has been collected over time.

The Life Cycle of Butterflies

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer. Types of investigations include describing objects and organisms and classifying them.
- Simple instruments, such as magnifiers and rulers, provide more information than scientists obtain using only their senses.

Life Science

Characteristics of organisms

- Organisms have basic needs. For example, animals need air, water, and food. Organisms can survive only in environments in which their needs can be met. The world has many different environments, and distinct environments support the life of different types of organisms.
- Each plant and animal has different structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking.
- The behavior of individual organisms is influenced by internal cues (such as hunger) and external cues (such as a change in the environment). Humans and other organisms have senses that help them detect internal and external cues.

Life cycles of organisms

- Animals have life cycles that include being born, developing into adults, reproducing, and eventually dying. The details of this life cycle are different for different organisms.
- Plants and animals closely resemble their parents.

Organisms and their environments

- An organism's patterns of behavior are related to the nature of that organism's environment, including the kinds and numbers of other organisms present, the availability of food and resources, and the physical characteristics of the environment.

Science and Technology

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering these questions and explaining the natural world.
- Scientists often work in teams with different individuals doing different things that contribute to the results.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Science in Personal and Social Perspectives

Personal health

- Nutrition is essential to health. Students should understand how the body uses food and how various foods contribute to health and growth.

Types of resources

- Resources are things that we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources are basic materials, such as air and water; some are produced from basic resources, such as food; and some are nonmaterial, such as beauty.

Changes in environments

- Environments are the space, conditions, and factors that affect an individual's and a population's ability to survive.

History and Nature of Science

Science as a human endeavor

- Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Evidence, models, and explanation

Constancy, change, and measurement

Form and function

Soils

Narrative Summary

In this unit, students investigate the chief components of soil—sand, clay, and humus—and explore the relationship between soil and plant growth. Early in the unit, they create their own compost bags. This activity enables them to observe the decomposition of different types of organic materials over time. Students observe and read about earthworms to learn about their connection to plant roots and soil. The students also conduct tests that enable them to observe and compare such properties of soil as odor, appearance, and texture. Phenomena such as settling, water content, and soil consistency are also explored. These observations are then related to plant growth, as students plant cucumber seeds in a clear plastic tube. By observing root growth, students learn about the role of roots in keeping the plant anchored and upright. In a final activity, students apply what they have learned to investigate a sample of local garden soil.

Science Content

Soils are a complex mix of many materials and different-sized particles. Students investigate the physical properties of three major soil components and then extend their investigations to observations of plant growth in various soil mixtures. In order to investigate organisms and their environments, students observe plants and animals—including redworms—within soil samples. Students keep records and synthesize information from multiple investigations. Using simple tools, students record heights of plants. They then pool their data and draw conclusions about what their local soil contains and its effect on plant growth. Reading selections extend the content of the unit and address such concepts as how people of various cultures use earth materials to build homes and other structures.

Assessment

Prior knowledge about soils is assessed through a brainstorming activity in Lesson 1 and revisited throughout the unit and during a post-unit assessment. Through a series of investigative activities, students learn about the components of soils. Their results and data records can be evaluated or observed to determine growth in skills, attitudes, and concepts addressed in the unit. Two embedded assessments challenge students to apply soil tests used throughout the unit to new soil samples. In Lesson 8, students use soil tests to analyze an unfamiliar mixture of soil components. In Lessons 14 and 15, students apply these same tests to a local soil sample. Suggestions for additional assessments include guidelines for conducting student conferences, evaluating student work products, and encouraging students to share what they have learned with visitors.

Goals for *Soils*

In this unit, students investigate the properties of three soil components—sand, clay, and humus—as well as their own local soil. They also explore the relationship between soil, roots, and plants. From their experiences, they are introduced to the following concepts, skills, and attitudes.

Concepts

- Soil contains particles of different sizes.
- Soil may contain animals, plants, and their remains.
- Over time, dead plants become part of soil.
- Composting—especially with worms—is an effective way to recycle old plants and other discarded organic matter.
- Sand, clay, and humus are three of the basic components in soil.
- Every soil component has unique properties that can be identified using simple tests.
- Different soils absorb water at different rates.
- Many factors, including soil, affect plant and root growth.

Skills

- Performing simple tests to describe and identify soil components.
- Observing, recording, and organizing test results.
- Interpreting test results to draw conclusions about soil composition.
- Reflecting on test results to predict how plants will grow in different soils.
- Assembling laboratory materials for soil experiments.
- Communicating results and ideas through writing, drawing, and discussion.
- Applying previously learned concepts and skills to analyze unfamiliar soil samples.

Attitudes

- Developing enthusiasm for investigating soil.
- Appreciating the importance of soil for plant growth and animal life.
- Accepting that a range of outcomes is valid.
- Valuing the importance of recycling.

Soils

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Ask a question about objects, organisms, and events in the environment.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigations public; they describe the investigations in ways that enable others to repeat the investigations.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, weight, shape, color, and the ability to react with other substances.
- Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.

Life Science

The characteristics of organisms

- Organisms have basic needs.
- Each plant or animal has different structures that serve different functions.

Organisms and their environments

- An organism's patterns of behavior are related to the nature of that organism's environment, including the kinds and numbers of other organisms present, the availability of food and resources, and the physical characteristics of the environment.
- All organisms can cause change in the environment in which they live. Some of these changes are beneficial. Others are detrimental.

Earth and Space Science

Properties of earth materials

- Earth materials are solid rocks and soils, water, and the gases of the atmosphere. The varied materials have different physical and chemical properties which make them useful in different ways, for example, as resources for growing plants.
- Soils have properties of color and texture, capacity to retain water, and ability to support growth of plants.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

Understandings about science and technology

- Science is one way of answering questions and explaining the natural world.
- Scientists and engineers work in teams.

- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations and measurements. They help scientists see, measure, and do things they could not otherwise see, measure, and do.

History and Nature of Science

Science as a human endeavor

- Science and technology have been practiced by people for a long time.
- Men and women have made a variety of contributions throughout the history of science and technology.

Unifying Concepts and Processes

Systems, order, and organization
Evidence, models, and explanation
Constancy, change, and measurement
Form and function and measurement

Changes

Narrative Summary

In this unit, students expand their understanding of solids, liquids, and gases by exploring changes in state. They investigate freezing, melting, evaporation, and condensation of water. In a sequence of lessons, students produce a mixture of two solids and a mixture of solids with liquids and observe the results. They work through several methods to separate mixtures: sieving, filtration, evaporation, and chromatography. The students set up races that involve sugar dissolving in water and observe the effects of particle size and water temperature on the rate at which the sugar dissolves. They also observe crystals formed as a result of evaporation. Students observe some changes that occur immediately and some that occur over time, and they begin to recognize the characteristics of chemical reactions. They investigate rusting, and they observe and collect the gas formed by mixing an effervescent tablet in water. Students have several opportunities to practice their new skills in lessons in which they devise ways of separating a mystery mixture and plan and carry out investigations that involve other changes.

Science Content

This unit focuses on the foundations of scientific inquiry as students conduct simple investigations to observe everyday changes. Students make and record observations, mix substances, and observe the formation of new substances. They explore concepts from physical science, such as the ability of objects to react with other substances and changes of state. Designing solutions and problem solving are also emphasized as students try to find the fastest method for melting their ice cubes. Presenting results to others and comparing observations are at the heart of this unit.

Assessment

Changes begins with a pre-unit assessment in which students share what they know and their questions about solids and liquids and how they shange. Looking at "Change Cards" that illustrate everyday scenes, students identify solids and liquids and predict how the materials pictured might change over time. Students also make and record observations of what happens when a solid and a liquid are mixed. These pre-unit assessment activities are matched to a post-unit assessment. Two embedded assessments provide guidelines for assessing students' progress. In Lesson 11, students apply their experiences from the first 10 lessons to identify and separate components of a mystery mixture. In Lessons 15 and 16, students use the concepts and skills learned in the second half of the unit to create their own "recipe" of changes. Student progress can be measured individually or in small groups by evaluating record sheets and student journal entries; by comparing pre- and post-unit investigations; and through class discussions, questions, and investigations. Additional assessments at the end of the unit include a student self-assessment, a listening activity, and suggestions for creating portfolio assessments.

Goals for *Changes*

In this unit, students expand their understanding of solids, liquids, and gases and how they change. Through their experiences, students are introduced to the following concepts, skills, and attitudes.

Concepts

- Changes occur all the time in the world around us.
- Some changes happen quickly, and others take place over a period of time.
- Substances can be classified as solids, liquids, or gases.
- Solids, liquids, and gases can be described by their properties. These properties include color, size, shape, odor, texture, and weight.
- Water can freeze into a solid and then melt into a liquid again.
- Water can evaporate into a gas and then condense into a liquid again.
- Mixtures can be made by combining solids, liquids, or gases, or a combination of these.
- A substance can change in appearance yet remain the same substance.
- Some mixtures can be separated using a sieve, a filter, or the processes of evaporation and chromatography.
- When some solids—such as salt and sugar—are added to water, they dissolve and seem to disappear.
- Some dissolved solids can be recovered as crystals through evaporation.
- When a solid is dissolving in a liquid, the size of the solid particles, the temperature of the liquid, and stirring can affect the speed at which the solid dissolves.
- When two or more substances are mixed, a chemical reaction may occur. Indicators of a chemical reaction can include a change in color, a change in temperature, or the production of a new substance, such as rust or gas.

Skills

- Observing and describing changes that occur in everyday experiences.
- Observing and describing the properties of solids, liquids, and gases.
- Observing and describing changes that result from mixing substances.
- Observing and describing water as it freezes, melts, evaporates, and condenses.
- Comparing mixtures.
- Separating mixtures with a sieve, a filter, and the processes of evaporation and chromatography.
- Performing tests to investigate a mystery mixture.
- Communicating ideas, observations, and experiences through writing, drawing, discussion, and presentation.
- Predicting, observing, classifying, and recording results in a journal and on record sheets, class charts, and brainstorming lists.
- Designing and testing a recipe in which substances are mixed to create a chemical reaction.

Attitudes

- Becoming curious about the changes that occur in the world around us.
- Developing an interest in investigating changes in the properties of solids and liquids.
- Developing an appreciation for the importance of recording and organizing information on record sheets, science journals, and class charts.

Changes

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigations public; they describe the investigations in ways that enable others to repeat the investigations.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, shape, color, temperature, and the ability to react with other substances.
- Materials can exist in different states—solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling.

Light, heat, electricity, and magnetism

- Heat can be produced in many ways, one of which is by mixing one substance with another.

Earth and Space Science

Properties of earth materials

- Earth materials are solid rocks, soil, water, and the gases of the atmosphere. These materials have different physical and chemical properties.

Changes in the earth and sky

- Weather changes from day to day and over the seasons.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- Scientists and engineers often work in teams in which different individuals do different things that contribute to the results.
- Tools help scientists make better observations, measurements, and equipment for investigations.

Science in Personal and Social Perspectives

Personal health

- Safety and security are basic needs of humans. Safety involves freedom from danger, risk, or injury. Student understanding includes following safety rules for home and school.

History and Nature of Science

Science as a human endeavor

- Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Balancing and Weighing

Narrative Summary

This unit introduces students to the relationship between balance and weight. Experiences with a beam balance introduce students to the concept that amount of weight, position of weight, and position of the fulcrum affect balance. Work with an equal-arm balance challenges students to place objects in serial order on the basis of weight and to appreciate that weighing is the process of balancing an object against a certain number of standard objects. In the final lessons, students turn to a series of problem-solving investigations with the equal-arm balance and cupfuls of four different foods. These activities provide an opportunity to explore the relationship between weight, density, and volume.

Science Content

This unit provides students with a variety of experiences and materials that help them build conceptual models for further investigations in the physical sciences. Using a fulcrum and beam, students investigate how the amount, distance, and position of objects affect balance. Designing and building mobiles gives students the opportunity to apply their knowledge of fulcrums and equilibrium to a new situation. Students build on their knowledge of standard units as they use an equal-arm balance to investigate weight, density, and volume.

Assessment

A matched pre- and post-unit brainstorming session and activity help teachers assess students' growth in concepts and skills. An embedded assessment in Lesson 5 and a culminating assessment in Lesson 16 allow teachers to assess the knowledge and skills that students have attained in previous lessons. Additional assessments at the end of the unit provide suggestions for evaluating student journal entries and class products. Guidelines for conducting student conferences are given.

Goals for *Balancing and Weighing*

In this unit, students expand their understanding of the relationship between balance and weight as they explore activities in balancing, comparing, and weighing. Their experiences introduce them to the following concepts, skills, and attitudes.

Concepts

- Balance is affected by the amount of weight, the position of weight, and the position of the fulcrum.
- Weighing is the process of balancing an object against a certain number of standard units.
- The weight of an object is not determined by its size.
- Equal volumes of different foods will not all have equal weights; equal weights of different foods will not all have equal volumes.

Skills

- Performing simple experiments with balance.
- Applying previous experiences with balancing to build mobiles.
- Using an equal-arm balance to compare and weigh.
- Predicting the serial order for the weights of objects and foods.
- Applying strategies for comparing and weighing to solve problems.
- Recording results on record sheets, bar graphs, line plots, data tables, and Venn diagrams.
- Communicating ideas, observations, and experiences through writing, drawing, and discussion.
- Reading to learn more about balancing and weighing.

Attitudes

- Developing an interest in investigating balancing and weighing.
- Appreciating the importance of balancing and weighing in the everyday world.
- Accepting that a range of results is valid.
- Valuing the importance of simple scientific tools.

Balancing and Weighing

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientists use different kinds of investigations depending on the questions they are trying to answer.
- Simple instruments, like rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations and what they already know about the world.
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, weight, shape, and color. These properties can be measured using tools, such as balances.
- Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects.

Position and motion of objects

- The position of an object can be described by locating it relative to another object.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

Understandings about science and technology

- Science is one way of answering questions and explaining the natural world.
- Scientists and engineers work in teams.
- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations and measurements. They help scientists see, measure, and do things they could not otherwise see, measure, and do.

Science in Personal and Social Perspectives

Science and technology in local challenges

- People continue inventing new ways of doing things, solving problems, and getting work done.

History and Nature of Science

Science as a human endeavor

- Science and technology have been practiced by people for a long time.
- Men and women have made a variety of contributions throughout the history of science and technology.
- Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization
Evidence, models, and explanation
Constancy, change, and measurement
Evolution and equilibrium
Form and function

PART 5

Science and Technology for Children™

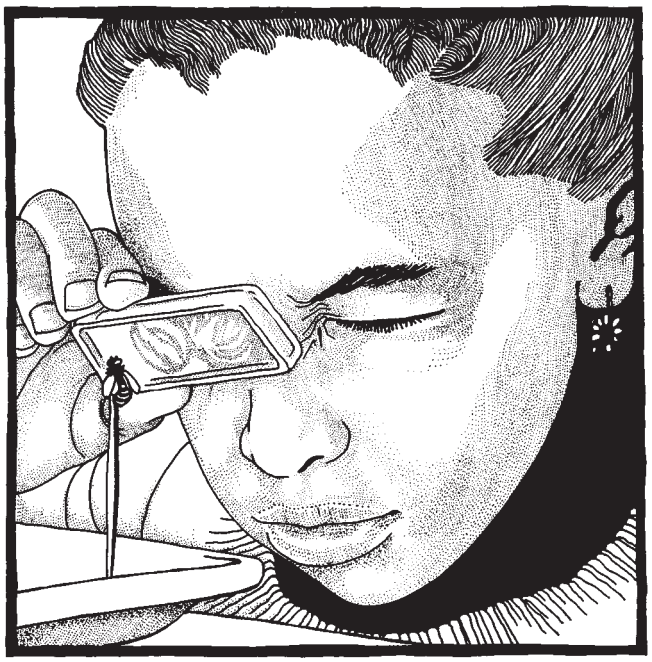
THIRD-GRADE UNITS

Grade	Life, Earth, and Physical Sciences and Technology			
1	Organisms	Weather	Solids and Liquids	Comparing and Measuring
2	The Life Cycle of Butterflies	Soils	Changes	Balancing and Weighing
3	**Plant Growth and Development**	**Rocks and Minerals**	**Chemical Tests**	**Sound**
4	Animal Studies	Land and Water	Electric Circuits	Motion and Design
5	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
6	Experiments with Plants	Measuring Time	Magnets and Motors	The Technology of Paper

Third-Grade STC™ Units and the NSES (K–4)

National Science Education Standards for Grades K–4	Plant Growth and Development	Rocks and Minerals	Chemical Tests	Sound
Science as Inquiry				
Abilities necessary to do scientific inquiry	●	●	●	●
Understandings about scientific inquiry	●	●	●	●
Physical Science				
Properties of objects and materials		●	●	●
Position and motion of objects				●
Light, heat, electricity, and magnetism		●	●	
Life Science				
Characteristics of organisms	●			●
Life cycles of organisms	●			
Organisms and environments	●			●
Earth and Space Science				
Properties of earth materials	●	●	●	
Objects in the sky				
Changes in earth and sky		●		
Science and Technology				
Abilities of technological design	●			●
Understandings about science and technology	●	●	●	●
Abilities to distinguish between natural objects and objects made by humans	●	●	●	
Science in Personal and Social Perspectives				
Personal health			●	●
Characteristics and changes in populations				
Types of resources		●	●	
Changes in environments		●		
Science and technology in local challenges	●			●
History and Nature of Science				
Science as a human endeavor	●	●	●	●
Unifying Concepts and Processes				
Systems, order, and organization	●	●	●	●
Evidence, models, and explanation	●	●	●	●
Constancy, change, and measurement	●	●	●	●
Evolution and equilibrium		●		
Form and function	●	●		●

Plant Growth and Development



Narrative Summary

In this unit, students have the opportunity to observe each stage in the life cycle of a simple plant. Working with Wisconsin Fast Plants™ *(Brassica rapa)*, which germinate, mature, and go to seed within a 40-day period, students plant seeds and watch the seedlings emerge. Later, they thin and transplant seedlings. As they watch their plants grow, students learn that plants need nutrients from the soil, as well as water and light, to thrive. As the unit expands to focus on the interdependence of living things, students cross-pollinate the flowers with dried honeybees. Finally, they harvest mature seeds and determine seed yields. These experiences deepen students' understanding of the characteristics of living organisms and their relationship with and dependence on their environment.

Science Content

Plant life cycles, resource needs of organisms, and environmental changes are investigated with Wisconsin Fast Plants™. Each student keeps a laboratory notebook to record the many changes, from seed to flower, of these plants. Students translate their findings and measurements into graphs. Measurement in standard units and comparisons between different groups are key to interpreting cause-and-effect relationships. Using the processes of technological design, students design and build models of the *Brassica* plant and a bee. Students communicate their designs in a class presentation and demonstrate their knowledge of the science concepts learned in the unit.

Assessment

Students begin the unit with a brainstorming session in which they share what they know and want to know about plants. Assessments in this session and Lesson 10 are matched with a post-unit discussion that provides tools to help evaluate student progress in understanding the plant's life cycle and learning about the anatomy of the bee. Throughout the unit, student notebooks, graphs, and record sheets can be used for assessment and evaluation. Using the record chart provided, teachers can track each student's progress in the unit by evaluating student products and skills. A sequencing activity using life cycle cards and the evaluation of a student-generated illustration of a bee are among the additional assessments found at the close of the unit.

Goals for *Plant Growth and Development*

In this unit, students observe the life cycle of the *Brassica rapa* (Wisconsin Fast Plants™). Their experiences introduce them to the following concepts, skills, and attitudes.

Concepts

- Many plants follow a life cycle that begins with growth from a seed and proceeds through the production of seeds.
- Plants have distinct stages in their life cycle.
- To live and grow, plants need light, water, and nutrients from the soil.
- Flowering plants must be pollinated in order to produce seeds.
- Many plants are pollinated by bees.
- A flower's pollen sticks to a bee, but some rubs off when the bee feeds at other flowers.
- One seed produces one plant; one plant can produce many seeds.

Skills

- Planting and caring for the *Brassica rapa.*
- Observing, describing, and recording changes in plants.
- Comparing and discussing changes occurring in plants over time.
- Measuring and recording the growth of plants.
- Using graphs to display and compare growth patterns.
- Predicting future growth from observations and measurements.
- Reading to learn more about plants.
- Communicating results and reflecting on experiences through writing, drawing, and discussion.

Attitudes

- Developing an interest in studying the life cycle of plants.
- Developing sensitivity to the needs of plants.
- Developing an awareness of the interaction between plants and animals.

Plant Growth and Development

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in an environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers and rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations.
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Life Science

Characteristics of organisms

- Organisms have basic needs; plants require air, water, nutrients, and light. Organisms can survive only in environments in which their needs are met.
- Each plant has different structures that serve different functions in growth, survival, and reproduction.

Life cycles of organisms

- Plants have life cycles that include developing into adults, reproducing, and eventually dying.
- Plants closely resemble their parents.
- Many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from interaction with the environment.

Organisms and their environments

- All animals depend on plants.
- An organism's patterns of behavior are related to the nature of that organism's environment. When the environment changes, some plants survive and reproduce, and others die.

Earth and Space Science

Properties of earth materials

- Earth materials, such as soil and water, are useful in growing plants.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- Scientists often work in teams with different individuals doing different things that contribute to the results.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things they could not otherwise see, measure, and do.

Abilities to distinguish between natural objects and objects made by humans

- Some objects occur in nature while others have been designed by people.
- Objects can be categorized into two groups, natural and designed.

Science in Personal and Social Perspectives

Science and technology in local challenges

- People continue inventing new ways of doing things, solving problems, and getting work done.

History and Nature of Science

Science as a human endeavor

- Many people choose science as a career and devote their lives to studying it. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Form and function

Rocks and Minerals

Narrative Summary

Students explore the differences and similarities between rocks and minerals by investigating samples of these earth materials, performing a series of tests similar to geologists' field tests, and reading about rocks and minerals and how they are used. The first lessons focus on rocks. The students then turn their attention to a set of 12 minerals and test them to identify properties such as streak color, luster, transparency, hardness, shape, and magnetism. After completing these observations, students compile them into their own "Minerals Field Guide." In a culminating activity, they are challenged to apply their knowledge and skills to identify new minerals. They then report on how rocks and minerals are used.

Science Content

Students investigate the properties of earth materials using techniques similar to those of a geologist. As part of their investigations of rocks, they read about how rocks are changed by heat and pressure. Students then explore the color, transparency, crystal form, luster, hardness, and magnetism of a set of 12 minerals and, on the basis of these tests, identify the minerals by name. Through a variety of reading selections, the history and nature of science are explored in depth as students learn more about the origin of common rock and mineral names and the various uses of minerals over the centuries. Science in personal and social perspectives is addressed as students examine and report on ways in which minerals and rocks are used as a resource.

Assessment

During brainstorming sessions in Lessons 1 and 5, students share what they know and want to know about rocks and minerals, respectively. Throughout the unit and following Lesson 16, students revisit their brainstorming lists to assess their prior thinking and address misconceptions, if needed. Problem solving and reasoning can be assessed throughout this unit as students perform field tests to identify minerals. Students' observations, data collection, and recordkeeping also provide evidence of their understanding. In Lesson 15, students' investigations of three "mystery minerals" serve as an embedded assessment and allow the teacher to assess growth in concepts, skills, and attitudes developed throughout the unit. Additional assessments include a class presentation in which students share with visitors what they have learned in the unit, guidelines for conducting student/teacher conferences in which students share their knowledge of rocks and minerals, and a paper-and-pencil student self-assessment that helps students reflect on the unit.

Goals for *Rocks and Minerals*

In this unit, students investigate rocks and minerals. Through their experiences, students are introduced to the following concepts, skills, and attitudes.

Concepts

- Rocks are aggregates of minerals, and they may also contain organic matter.
- Different rocks have different properties.
- The properties of rocks reflect the way they were formed and the minerals in them.
- Each mineral is composed of only one substance, and that substance is the same in all samples of the mineral.
- Minerals differ in color, texture, smell, luster, transparency, hardness, shape, and reaction to magnets.
- The properties of rocks and minerals determine how they are used.

Skills

- Using senses to observe and describe rocks and minerals.
- Recording and discussing observations of rocks and minerals.
- Sorting minerals on the basis of similarities and differences in identified properties.
- Performing and interpreting results of the following tests on minerals: streak, transparency, luster, hardness, and magnetism.
- Recording and discussing results of tests on minerals.
- Reading for more information on minerals and rocks.
- Communicating observations and test results through writing and discussion.
- Reflecting on experiences through writing and discussion.
- Applying previously learned concepts and skills to solve a problem.

Attitudes

- Developing an interest in investigating rocks and minerals.
- Recognizing the importance of using multiple tests to create a profile of a mineral.
- Valuing scientific information that has been collected and verified over time.

Rocks and Minerals

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in an environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, weight, shape, color, and the ability to react with other substances. These properties can be measured using tools.
- Objects are made of one or more materials. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.

Light, heat, electricity, and magnetism

- Light travels in a straight line until it strikes an object.
- Magnets attract and repel each other and certain kinds of other materials.

Earth and Space Science

Properties of earth materials

- Earth materials include solid rocks and soils. The varied materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials and as resources for fuel. Earth materials provide many of the resources that humans use.
- Fossils provide evidence about plants and animals that lived long ago and the nature of the environment at that time.

Changes in the earth and sky

- The surface of the earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes, such as landslides, volcanic eruption, and earthquakes.

Science and Technology

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.

- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Abilities to distinguish between natural objects and objects made by humans

- Some objects occur in nature; others have been designed and made by people.
- Objects can be categorized into two groups, natural and designed.

Science in Personal and Social Perspectives

Types of resources

- Resources are things that we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources are basic materials, such as air, water, and soil; some are produced from basic resources, such as food, fuel, and building materials.
- The supply of many resources is limited.

Changes in environments

- Some environmental changes occur slowly, and others occur rapidly.

History and Nature of Science

Science as a human endeavor

- Science and technology have been practiced by people for a long time.
- Men and women have made a variety of contributions throughout the history of science and technology.
- Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Evolution and equilibrium

Form and function

Chemical Tests

Narrative Summary

This unit introduces third-graders to the science of chemistry by challenging them to explore and determine the identity of five common household chemicals: sugar, alum, talc, baking soda, and cornstarch. Students begin by focusing on the physical properties of color, form, and texture. Next, they explore chemical properties by observing how the five powders interact with water, vinegar, iodine, and red cabbage juice. These tests enable them to explore phenomena such as crystallization and to observe the processes of evaporation and filtration. Finally, students apply their skills and their knowledge of the five chemicals to identify a variety of "mystery" mixtures. As a result of conducting these investigations, students develop scientific skills such as observing and recording results, forming conclusions on the basis of experience, communicating results, and applying their knowledge to solve problems.

Science Content

This unit focuses on the properties of materials that can be observed and investigated with simple physical and chemical tests. Students learn about chemicals through direct experience with everyday substances and observe changes in properties as they mix one substance with another. Through investigation, students are introduced to solubility, filtration, evaporation, and acids, bases, and neutrals. Students develop basic laboratory skills; strengthen their ability to collect, record, and organize data; and learn about laboratory safety.

Assessment

Chemical Tests begins with a pre-unit assessment lesson in which students share what they know and would like to know about chemicals. Students also observe and describe an unknown material. In a matched post-unit assessment, the class revisits the pre-unit assessment questions and activity. In Lesson 11, as students review evidence gathered in the unit, teachers can assess students' ability to interpret the importance of specific test results in identifying unknowns. A set of criteria helps guide this assessment. An embedded assessment in Lesson 16 challenges students to synthesize and apply what they have learned to identify unlabeled test liquids. Additional assessments at the close of the unit include a student self-assessment and a performance-based assessment in which students analyze the composition of unknown mixtures they created in Lesson 14.

Goals for *Chemical Tests*

In this unit, students investigate the properties of a variety of common household chemicals. From their experiences, they are introduced to the following concepts, skills, and attitudes.

Concepts

- Common household chemicals have different physical and chemical properties.
- Chemicals undergo changes in form, color, or texture when they are mixed together, separated, or heated.
- Some chemicals can be identified by their interaction with water, vinegar, iodine, red cabbage juice, and heat.
- Different types of mixtures, such as solutions or suspensions, are created when solids are combined with water.
- Evaporation and filtration are methods for separating mixtures of solids and liquids.
- Some chemicals can be classified as acids, bases, or neutral substances on the basis of their reactions with red cabbage juice.

Skills

- Observing and describing properties of materials.
- Learning to perform different physical and chemical tests.
- Predicting, observing, describing, and recording results of tests.
- Analyzing and drawing conclusions from the results of tests.
- Comparing and contrasting test results to define the properties of household chemicals so they can be identified.
- Supporting conclusions with reasons based on experiences.
- Communicating results and reflecting on experiences through writing and discussion.
- Applying previously learned knowledge and skills to solve a problem.
- Reading to enhance understanding of chemistry concepts.
- Developing proper laboratory techniques to ensure safety and avoid contamination.

Attitudes

- Developing an interest in exploring and investigating properties of chemicals.
- Recognizing the importance of guidelines for experimentation.
- Developing an awareness of the importance of chemicals in our lives.
- Developing an appreciation for the safe handling of chemicals.

Chemical Tests

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools.
- Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.
- Materials can exist in different states—solid, liquid, and gas.

Light, heat, electricity, and magnetism

- Heat can be produced in many ways such as burning or mixing one substance with another.

Earth and Space Science

Properties of earth materials

- Earth materials are varied and have different physical and chemical properties that make them useful in different ways. Earth materials provide many of the resources needed by humans.

Science and Technology

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques to solve them.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Abilities to distinguish between natural objects and objects made by humans

- Some objects occur in nature; others have been designed and made by people to solve human problems and enhance the quality of life.

Science in Personal and Social Perspectives

Personal health

- Safety and security are basic needs of humans. Safety involves freedom from danger, risk, or injury.

Types of resources

- Resources are things we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources are basic materials and some are produced from basic resources.

History and Nature of Science

Science as a human endeavor

- Although men and women using scientific inquiry have learned much about the objects, events, and phenomena in nature, much more remains to be understood.
- Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Sound

Narrative Summary

Third-graders use tuning forks, slide whistles, strings, and other sound-producing objects to investigate the characteristics of sound. Students learn that sound is caused by vibrations, and they explore how sound travels. They learn about the relationship of pitch and volume to the frequency and amplitude of vibrations. They discover, for example, that they can alter pitch by varying the length or tension of a string. Constructing simple stringed instruments, they discover how they can increase the volume of the sound produced by the strings. Students investigate the characteristics of another common sound-producing mechanism—the human vocal cords—and build model vocal cords. They also learn about the anatomy and functioning of the human ear. They apply what they learn in the unit by designing and building musical instruments or other sound-producing devices.

Science Content

Students investigate objects of differing length, thickness, and tension as they vibrate and produce different pitches. Students engage in technological design as they design and build their own stringed instruments, develop criteria for comparing different designs, and investigate sounds using their own instruments. Investigations of how size, tension, and material affect pitch and volume enable students to incorporate these variables into the design of their own musical instrument. By making simple models of the human eardrum and vocal cords, students further explore the concepts of vibration and pitch.

Assessment

In a pre-unit assessment in Lesson 1, students develop three class charts in which they generate their own ideas about sounds they have heard, ways to make sounds, and questions they have about sound. Students revisit these discussions at the end of the unit. Two embedded assessments allow teachers to assess students' abilities to apply concepts learned in the unit to a new situation. First, in Lesson 7, students are assessed as they design a wind instrument. Then, in Lessons 15 and 16, they are challenged to design any type of musical instrument or other device to show what they have learned about how sound is produced and changed, how it travels, and how it is received by the human ear. Additional assessments at the close of the unit include a student self-assessment, suggestions for reviewing student products, and guidelines for conducting individual student meetings.

Goals for *Sound*

In this unit, students investigate the phenomenon of sound. Their experiences introduce them to the following concepts, skills, and attitudes.

Concepts

- Sounds are produced by vibrating objects and vibrating columns of air.
- Pitch and volume are two characteristics of sound.
- Changing the way an object vibrates can change the pitch and volume of the sound produced.
- Pitch is determined by the frequency of the vibrations; volume is determined by the amplitude of the vibrations.
- Changing the length, tension, or thickness of a string affects the frequency of vibration and, therefore, the pitch of the sound produced.
- The human ear has a membrane that vibrates when sound reaches it; the ear and the brain translate these vibrations into the sensation of sound.
- Sound is produced by the human vocal cords as air moves through the tightened cords.

Skills

- Performing experiments with sound.
- Describing the results of investigations with sound.
- Comparing and discussing the volume and pitch of the sounds produced.
- Communicating results through writing and with graphs.
- Reflecting on experiences with sound through writing and discussion.
- Using the results of previous experiments with sound to predict outcomes in new situations.
- Applying previously learned concepts and skills to design new sound-producing devices.
- Reading to obtain more information about sound, hearing, and the vocal cords.

Attitudes

- Developing an interest in investigating sound.
- Recognizing the importance of hearing safety.

Sound

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers and rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, shape, and the ability to react with other substances. Those properties can be measured using tools, such as a ruler.
- Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made.

Position and motion of objects

- An object's motion can be described.
- Sound is produced by vibrating objects. The pitch of the sound can be varied by changing the rate of vibration.

Life Science

Characteristics of organisms

- The behavior of organisms is influenced by internal and external cues. Humans and other organisms have senses that help them detect internal and external cues.

Organisms and their environments

- All organisms cause changes in the environment in which they live. Some of these changes are detrimental to the organism or other organisms, whereas others are beneficial.
- Humans change environments in ways that can be either beneficial or detrimental for themselves and other organisms.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

Understandings about science and technology

- People have always had questions about their world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.

- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Science in Personal and Social Perspectives

Personal health

- Safety and security are basic needs of humans.

Science and technology in local challenges

- People continue inventing new ways of doing things, solving problems, and getting work done. New ideas and inventions often affect other people.
- Science and technology have greatly improved health and communication.

History and Nature of Science

Science as a human endeavor

- Science and technology have been practiced by people for a long time.
- Men and women have made a variety of contributions throughout the history of science and technology.
- Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Form and function

PART 6

Science and Technology for Children™

FOURTH-GRADE UNITS

Grade	Life, Earth, and Physical Sciences and Technology			
1	Organisms	Weather	Solids and Liquids	Comparing and Measuring
2	The Life Cycle of Butterflies	Soils	Changes	Balancing and Weighing
3	Plant Growth and Development	Rocks and Minerals	Chemical Tests	Sound
4	**Animal Studies**	**Land and Water**	**Electric Circuits**	**Motion and Design**
5	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
6	Experiments with Plants	Measuring Time	Magnets and Motors	The Technology of Paper

Note: To accommodate local curriculum specifications and provide grade-level flexibility, fourth-grade STC™ units have been aligned with both the K–4 and 5–8 content standards.

Fourth-Grade STC™ Units and the NSES (K–4)

National Science Education Standards for Grades K–4	Animal Studies	Land and Water	Electric Circuits	Motion and Design
Science as Inquiry				
Abilities necessary to do scientific inquiry	●	●	●	●
Understandings about scientific inquiry	●	●	●	●
Physical Science				
Properties of objects and materials		●	●	●
Position and motion of objects		●		●
Light, heat, electricity, and magnetism			●	
Life Science				
Characteristics of organisms	●			
Life cycles of organisms	●			
Organisms and environments	●	●		
Earth and Space Science				
Properties of earth materials		●		
Objects in the sky				
Changes in earth and sky		●		
Science and Technology				
Abilities of technological design	●	●	●	●
Understandings about science and technology	●	●	●	●
Abilities to distinguish between natural objects and objects made by humans	●	●		
Science in Personal and Social Perspectives				
Personal health			●	
Characteristics and changes in populations				
Types of resources	●	●	●	
Changes in environments	●	●		
Science and technology in local challenges		●	●	●
History and Nature of Science				
Science as a human endeavor	●	●	●	●
Unifying Concepts and Processes				
Systems, order, and organization	●	●	●	●
Evidence, models, and explanation	●	●	●	●
Constancy, change, and measurement	●	●	●	●
Evolution and equilibrium	●	●		●
Form and function	●	●	●	●

Fourth-Grade STC™ Units and the NSES (5–8)

National Science Education Standards for Grades 5–8	Animal Studies	Land and Water	Electric Circuits	Motion and Design
Science as Inquiry				
Abilities necessary to do scientific inquiry	●	●	●	●
Understandings about scientific inquiry	●	●	●	●
Physical Science				
Properties and changes of properties in matter		●	●	
Motions and forces		●		●
Transfer of energy			●	●
Life Science				
Structure and function in living systems	●			
Reproduction and heredity	●			
Regulation and behavior	●	●		
Populations and ecosystems				
Diversity and adaptations of organisms	●			
Earth and Space Science				
Structure of the earth system		●		
Earth's history		●		
Earth in the solar system		●		
Science and Technology				
Abilities of technological design	●	●	●	●
Understandings about science and technology	●	●	●	●
Science in Personal and Social Perspectives				
Personal health	●		●	
Populations, resources, and environments		●		
Natural hazards		●		
Risks and benefits		●		
Science and technology in society	●	●	●	●
History and Nature of Science				
Science as a human endeavor	●	●	●	●
Nature of science	●	●	●	●
History of science		●	●	●
Unifying Concepts and Processes				
Systems, order, and organization	●	●	●	●
Evidence, models, and explanation	●	●	●	●
Constancy, change, and measurement	●	●	●	●
Evolution and equilibrium	●	●		●
Form and function	●	●	●	●

Animal Studies

Narrative Summary

By caring for and observing three animals from different habitats—the dwarf African frog, the fiddler crab, and the land snail—students learn about what animals need to survive, the primary parts of their anatomical structure, and the ways in which they are suited for life in a particular environment. Students create and maintain individual logs in which they record their observations of each animal over time. These observations focus on animal behavior, including methods for food getting, movement, and protection. Toward the end of the unit, students apply what they have learned about structure, habitat, survival needs, and behavior to study a fourth classroom animal: the human. They also conduct an animal research project and decide how they will present their findings to the class.

Science Content

This unit enhances students' sensitivity to and awareness of the diversity of life, the inter-dependence of living and nonliving things, and the ways in which creatures are adapted to life in particular environments. Understanding the nature of scientific investigation and developing skills in observing and recording behavior are key elements of this unit. Working as scientists do, students investigate the diversity of three animals from different habitats and study the ways that these animals are adapted to life in a particular environment. Students learn through observation that animals have specific needs, characteristics, and behaviors. Students observe ways in which animals depend on their environment and recognize that animals can cause changes in their environment.

Assessment

Students' preliminary ideas and questions are assessed through class brainstorming. The teacher can use information gained during this exercise to tailor learning activities and extensions. Following Lesson 16 is a post-unit assessment that is matched to several assessments in the first few lessons. Students use animal logs to record their observations, comparative drawings, and interpretations of each animal's behavior. These logs document the learning process and show the relationship between inquiry, investigation, and interpretation of findings. Lesson 12 is an embedded assessment in which students use their new knowledge of animals and animal behavior to pose a research question, define their observation guidelines, and set up and conduct their own research. Additional assessments at the end of the unit include a student self-assessment, an activity that asks students to determine considerations to be taken into account when providing a habitat for a pet, an activity to evaluate students' understanding of habitat elements and how animals are suited to them, and an activity in which students identify the characteristics of a good classroom pet.

Goals for *Animal Studies*

In this unit, students explore the relationship between an animal and its habitat, as well as some of the ways animal behaviorists study animals. Through their experiences, students are introduced to the following concepts, skills, and attitudes.

Concepts

- All the living and nonliving elements that surround an animal—such as other animals, plants, climate, water, air, and location—affect the life of that animal.
- One way scientists learn about animals is through close observation over an extended period of time.
- When conducting animal behavior research, scientists follow guidelines to ensure the accuracy of results.
- A habitat is the place where an animal finds the resources—food, water, shelter, and space—necessary to survive and reproduce.
- Each type of animal has specific needs, such as type of food, amount of water, and range of temperature.
- Certain behaviors and body structures enable animals to survive in a particular habitat.
- Humans are one of the only animals that can significantly change their behaviors to live in a variety of habitats.

Skills

- Observing and describing structural characteristics and behaviors of the dwarf African frog, fiddler crab, and land snail.
- Recording observations in an animal log.
- Developing questions and answering them through behavioral observation and research.
- Comparing and contrasting the dwarf African frog, fiddler crab, land snail, and human.
- Collecting, analyzing, and drawing conclusions from data.
- Supporting conclusions with reasons that are based on observation and experience.
- Predicting, observing, and recording the results of a simple experiment to test an animal's response to a sudden change in its habitat.
- Communicating ideas through writing and discussion.
- Reading to enhance understanding of the interaction between an animal and its habitat.
- Developing proper laboratory techniques that ensure the safety of living things.
- Maintaining animals outside their natural habitats.

Attitudes

- Developing an interest in exploring the characteristics and behaviors of animals.
- Gaining an appreciation for the variety of behaviors exhibited in the animal kingdom.
- Recognizing that humans can learn about themselves by learning about other animals.
- Developing an appreciation for the safe handling and observation of animals.
- Developing positive attitudes toward different forms of animal life.
- Appreciating the knowledge gained by observing animals over time.

GRADE 4

Animal Studies

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Life Science

Characteristics of organisms

- Organisms have basic needs. Each animal has different structures that serve different functions in growth and survival.
- The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as change in the environment).

Life cycles of organisms

- Many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual's interactions with the environment.

Organisms and their environments

- All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.
- An organism's patterns of behavior are related to the nature of that organism's environment, including the kinds and numbers of other organisms present, the availability of food and resources, and the physical characteristics of the environment. When the environment changes, animals survive and reproduce, and others die or move to new locations.
- All organisms cause changes in the environment where they live. Some of these changes are detrimental to the organism or other organisms, whereas others are beneficial.
- Humans depend on their natural and constructed environments. Humans change environments in ways that can be either beneficial or detrimental for themselves and other organisms.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.

- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Abilities to distinguish between natural objects and objects made by humans

- Some objects occur in nature; others have been designed and made by people to enhance the quality of life.

Science in Personal and Social Perspectives

Types of resources

- Resources are things that we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources are basic materials, such as air, water, and soil; some are produced from basic resources, such as food, fuel, and building materials; and some resources are nonmaterial, such as quiet places, beauty, security, and safety.

Changes in environments

- Environments are the space, conditions, and factors that affect an individual's and a population's ability to survive and their quality of life.
- Changes in environments can be natural or influenced by humans. Some changes are good, some are bad, and some are neither good nor bad.
- Some environmental changes occur slowly, and others occur rapidly.

History and Nature of Science

Science as a human endeavor

- Although men and women using scientific inquiry have learned much about the objects, events, and phenomena in nature, much more remains to be understood. Science will never be finished.
- Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, model, and explanation

Constancy, change, and measurement

Evolution and equilibrium

Form and function

GRADE 4

Animal Studies

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve experiments; and some involve seeking more information.
- Current scientific knowledge and understanding guide scientific investigations.
- Scientific explanations emphasize evidence.
- Asking questions and querying others' explanations is part of scientific inquiry.
- Scientific investigations sometimes result in new ideas for study or generate new methods for investigation.

Life Science

Structure and function in living systems

- Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include whole organisms.

Reproduction and heredity

- The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited, and others result from interactions with the environment.

Regulation and behavior

- All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.
- Behavior is one kind of response an organism can make to an internal or environmental stimulus.
- An organism's behavior evolves through adaptation to its environment.

Diversity and adaptations of organisms

- Species acquire many of their unique characteristics through biological adaptation. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival.

Science and Technology

Abilities of technological design

- Identify appropriate problems for technological design.
- Design a solution or product.
- Evaluate completed technological designs or products.
- Communicate the process of technological design.

Understandings about science and technology

- Scientific inquiry and technological design have similarities and differences. Scientists propose explanations for questions about the natural world, and engineers propose solutions relating to human problems and needs.
- Many different people in different cultures have made and continue to make contributions to science.

- Science and technology are reciprocal. Science drives technology as it addresses questions that demand more sophisticated instruments. Technology provides tools for investigation, inquiry, and analysis.

Science in Personal and Social Perspectives

Personal health

- Food provides energy and nutrients for growth and development.

Science and technology in society

- Science influences society. Scientific knowledge and the procedures used by scientists influence the way many individuals in society think about themselves, others, and the environment.
- Science and technology have advanced through contributions of many different people.
- Scientists and engineers work in many different settings.
- Science cannot answer all questions and technology cannot solve all problems or meet all needs.

History and Nature of Science

Science as a human endeavor

- Women and men of various backgrounds engage in the activities of science. Some scientists work in teams and some work alone, but all communicate extensively with others.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry.

Nature of science

- Scientists formulate and test their explanations using observations and experiments.
- In areas where active research is being pursued and in which there is not a great deal of experimental or observational evidence and understanding, it is normal for scientists to differ with one another about the interpretation of the evidence or theory being considered. Different scientists might draw different conclusions from the same data. Ideally, scientists acknowledge such conflict and work towards finding evidence that will resolve their disagreement.
- It is part of scientific inquiry to evaluate the results of scientific investigations.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Evolution and equilibrium

Form and function

Land and Water

Narrative Summary

In this unit, students investigate the interactions between land and water. Using a stream table as their model, students observe how runoff causes stream formation; how ground water forms; how soil is eroded, transported, and deposited; and how water shapes land. Students create hills, build dams, and grow vegetation. Miniature valleys, waterfalls, and canyons form in the stream tables as water flows over the soil. Students also deepen their appreciation for the vastness of stream systems by creating aerial diagrams of their stream table results. The stream table also serves as a basis for investigations of the water cycle. Through observing the model, manipulating certain parts of it, and testing interactions under various conditions, students discover how water changes the shape of land and how land formations, in turn, affect the flow of water. They connect the models to real-world examples and apply the concepts they have learned to photographs of land and water on earth. Through these applications, students are encouraged to observe land and water each day and search for evidence of interactions between land and water in the world around them.

Science Content

Modeling complex systems in order to investigate the relationships between the life, earth, and physical sciences is at the core of this unit. Stream table models provide students with evidence for land and water interactions. Science in personal and social perspectives—including changes in environments—provides the basis for investigations. The water cycle, natural hazards such as flooding, and dam building are investigated in terms of their effect on society and natural resources. Change, constancy, and measurement are central to this unit. Geological surface features are described and characterized through direct observation. Students observe physical properties of earth materials, collect and measure sediment moved during erosion, and record the path of streams to determine changes in land and water over time.

Assessment

Classroom brainstorming in Lesson 1 elicits students' prior knowledge of land and water. Students also examine photographs of local and national landscapes and share their thoughts about the interactions between land and water in each shot. The photos and brainstorming session serve as a pre-unit assessment of students' knowledge of interactions between land and water and are matched to a post-unit assessment following Lesson 16. In an embedded assessment in Lessons 15 and 16, students design their own landscapes and synthesize what they have learned. Additional assessments at the end of the unit include a student self-assessment, an activity that challenges students to apply what they have learned to investigate the path of polluted running water, and a method for observing the interactions between land and water in students' own environments.

Goals for *Land and Water*

In this unit, students investigate interactions between land and water. Through their experiences, students are introduced to the following concepts, skills, and attitudes.

Concepts

- Water has an important role in shaping the land on earth.
- Soil is a composite of weathered materials and organic matter at the earth's surface. Soil components include sand, silt, clay, gravel, and humus. Each soil component has unique properties.
- The wearing away and moving of soil and rock is erosion; the settling of eroded materials is deposition.
- The water cycle includes the processes of evaporation, condensation, and precipitation and the passage of water over and through land. These processes affect the shape of the land.
- Both the flow of water and the slope of the land affect erosion and deposition.
- Tributaries are branches of streams that converge to form the trunk of a larger stream, or river. Together, they act as a system that drains the land.
- Land forms, such as canyons and deltas, result from the action of flowing water.
- Humans can affect erosion and deposition in various ways, including clearing the land, planting vegetation, and building dams.
- Hills, rocks, plants, and dams may change the direction and flow of water.
- Aerial photographs are views of land or other surfaces as seen from above.

Skills

- Using stream table materials to investigate the interactions between water and land.
- Analyzing the materials that make up land and describing these materials on the basis of their properties.
- Testing the porous and adhesive qualities of earth materials.
- Comparing the changes in land created by water flowing over and through soil in a stream table.
- Relating stream table results to natural processes.
- Communicating the results of an investigation through record sheets, oral and written observations, and drawings.
- Investigating the effects of slope, flow, and natural land formations on erosion and deposition.
- Creating and labeling aerial drawings.
- Designing and building models of dams to test the effects of dams on land and water interactions.
- Designing and building models of landscapes, predicting how a landscape will affect the flow of water, and relating these modeled effects to land and water interactions on earth.
- Implementing a planned investigation and making and validating predictions.
- Identifying evidence within a model to support observations and conclusions.

Attitudes

- Recognizing the importance of models for investigating processes too large or complex to study firsthand.
- Developing an interest in the interactions between land and water and recognizing these interactions in the real world.
- Accepting that humans can attempt to control and affect the interactions between land and water.
- Appreciating the role that plants play in curbing erosion and runoff.
- Recognizing the role humans play in planning and designing landscapes that take into account the natural interactions of land and water.

Land and Water

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, like rulers and magnifiers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations and what they already know about the world. Good explanations are based on evidence from investigations.
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have observable properties, including size, weight, shape, and color.
- Objects are made of one or more materials and can be described by the properties from which they are made.
- Materials can exist in different states—solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another.

Position and motion of objects

- An object's motion can be described by tracing and measuring its position over time.
- The position of an object can be described by locating it relative to another object.

Life Science

Organisms and their environments

- When the environment changes, some plants and animals survive, and others die or move.
- All organisms cause changes in the environment where they live. Some changes are detrimental to the organism, others are beneficial.
- Humans depend on both their natural and their constructed environment. Humans change environments in ways that can either be beneficial or detrimental for other organisms.

Earth and Space Science

Properties of earth materials

- Earth materials are solid rocks and soils, water, and the gases of the atmosphere; these materials have different physical properties.
- Soils have properties of color and texture, capacity to retain water, and ability to support the growth of many kinds of plants.

Changes in the earth and sky

- The surface of the earth changes through processes such as erosion, weathering, and landslides.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

Understandings about science and technology

- Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques to solve problems.
- Scientists and engineers often work in teams with different individuals contributing to the results.
- Tools help scientists make better observations.

Abilities to distinguish between natural objects and objects made by humans

- Some objects occur in nature while others have been designed by people to solve human problems.
- Objects can be categorized into two groups, natural and designed.

Science in Personal and Social Perspectives

Types of resources

- Resources are things we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources include basic materials, such as air, water, and soil.
- The supply of many resources is limited. If used, resources can be extended through recycling and decreased use.

Changes in environments

- Changes in environments can be natural or influenced by humans.
- Some environmental changes occur slowly, and others occur rapidly.

Science and technology in local challenges

- People continue inventing new ways of doing things and solving problems.
- Science and technology have greatly improved health. These benefits of science and technology are not available to all of the people of the world.

History and Nature of Science

Science as a human endeavor

- There is still much more to be understood about science.
- Many people choose science as a career. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Evolution and equilibrium

Form and function

Land and Water

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Understandings about scientific inquiry

- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Mathematics is important in all aspects of scientific inquiry.
- Scientific explanations emphasize evidence.
- Asking questions and querying others' explanations is part of scientific inquiry.
- Scientific investigations sometimes result in new ideas for study or generate new methods for investigation.

Physical Science

Properties and changes of properties in matter

- A mixture of substances (such as soil and water) can often be separated into the original substances using one or more of the characteristic properties—such as density.

Motions and forces

- The motion of an object can be described by its position, direction of motion, and speed over time.

Life Science

Regulation and behavior

- All organisms must be able to obtain and use resources and grow.

Earth and Space Science

Structure of the earth system

- Land forms are the result of a combination of constructive and destructive forces, including deposition of sediment, weathering, and erosion.
- Soil consists of weathered rocks and decomposed organic material. Soils are often found in layers, each having a different composition and texture.
- Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates, rises and cools, condenses, and falls to the earth where it collects in lakes, oceans, soil, and in rocks underground.
- Clouds form by the condensation of water vapor.
- Living organisms have played many roles in the earth's system, including contributing to the weathering of rock.

Earth's history

- The earth processes we see today, including erosion, are similar to those that occurred in the past.

Earth in the solar system

- The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants and the water cycle.

Science and Technology

Abilities of technological design

- Identify appropriate problems for technological design.
- Design a solution or product.
- Implement a proposed design.

- Evaluate completed technological designs or products.
- Communicate the process of technological design.

Understandings about science and technology

- Scientific inquiry and technological design have similarities and differences. Scientists propose explanations for questions; engineers propose solutions to problems and needs.
- Science and technology are reciprocal. Technology also provides tools for investigation, inquiry, and analysis.
- Perfectly designed solutions do not exist. All solutions have trade-offs, such as cost, efficiency, and appearance.
- Technological designs have constraints, such as properties of materials. Other constraints limit choice in design.

Science in Personal and Social Perspectives

Populations, resources, and environments

- Causes of resource depletion vary from region to region and from country to country.

Natural hazards

- External processes of the earth system cause natural hazards, such as floods, that can destroy human and wildlife habitats.
- Human activities also can induce hazards through resource acquisition and land-use decisions. Such activities can accelerate many natural changes.

Risks and benefits

- Risk analysis considers the type of hazard and estimates the number of people that might suffer consequences.
- Risks are associated with natural hazards, such as floods.
- Important personal and social decisions are made based on perceptions of benefits and risks.

Science and technology in society

- Science and technology have advanced through contributions of many different people.
- Scientists and engineers work in many different settings.
- Science cannot answer all questions and technology cannot solve all problems or meet all needs.

History and Nature of Science

Science as a human endeavor

- Women and men of various backgrounds engage in the activities of science. Some scientists work in teams and some work alone, but all communicate extensively with others.
- Science requires different abilities.

Nature of science

- Scientists formulate and test their explanations using observations, experiments, and mathematical models.
- It is part of scientific inquiry to evaluate the results of scientific investigations.

History of science

- Many individuals have contributed to the traditions of science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Evolution and equilibrium

Form and function

Electric Circuits

Narrative Summary

In this unit, students are first introduced to the basic properties of electricity as they learn about electric circuits and the parts of a light bulb. Next, students learn about conductors and insulators and about the symbols used to represent the parts of a circuit in circuit diagrams. Students also explore different kinds of circuits, learn about switches, construct a flashlight, and investigate the properties of diodes. Finally, students apply their knowledge and skills to wire a cardboard house.

Science Content

Electric Circuits builds fundamental concepts in the physical sciences through direct experience with batteries and bulbs and through technological design projects. Students translate concrete models into the symbolic language of circuit diagrams. Troubleshooting and problem solving are used to pique students' interest in learning more about electricity, insulators, and conductors. The principles of technological design are used when students design and construct a flashlight and wire a cardboard house. Experimenting, confirming results, and consulting references are important aspects of students' investigations of electricity.

Assessment

Electric Circuits begins with a brainstorming session that serves as a pre-unit assessment. A matched post-unit assessment provides students and teachers with comparable data that indicate students' growth in knowledge and skills. An embedded assessment that uses a box that has hidden circuits wired underneath allows students to apply what they have learned about circuits. Lessons 15 and 16, in which students design and wire a cardboard house, also serve as an embedded assessment. Additional assessments at the end of the unit include suggestions for displaying and evaluating student products, additional performance-based assessment suggestions, and a paper-and-pencil assessment in which students reflect on concepts and skills addressed in the unit. A teacher's record chart of student progress is included for assessing student products and specific and general skills addressed in the unit.

Goals for *Electric Circuits*

In this unit, students expand their understanding of electricity through investigations with wires, batteries, bulbs, and switches. Their experiences introduce them to the following concepts, skills, and attitudes.

Concepts

- A complete electric circuit is required for electricity to light a bulb.
- A complete circuit can be constructed in more than one way using the same materials.
- Different types of electric circuits show different characteristics.
- A switch can be used to complete or interrupt a circuit.
- Some materials conduct electricity; these are called conductors.
- Some materials do not conduct electricity; these are called insulators.
- Electricity can produce light and heat.
- A diode conducts electricity in one direction only.

Skills

- Wiring simple electrical circuits.
- Predicting, observing, describing, and recording results of experiments with electricity.
- Drawing conclusions about circuits from the results of experiments.
- Building and using a simple circuit tester.
- Using symbols to represent the different parts of an electric circuit.
- Building a simple switch.
- Applying troubleshooting strategies to complete an incomplete circuit.
- Applying information about electric circuits to design and build a flashlight.
- Applying information about electric circuits to design and wire a house.
- Reading to learn more about electricity.
- Communicating results and ideas through writing, drawing, and discussion.

Attitudes

- Appreciating the need for safety rules when working with electricity.
- Developing an interest in electricity.
- Developing confidence in being able to analyze and solve a problem.

Electric Circuits

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances.
- Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials, and those properties can be used to sort a group of objects.

Light, heat, electricity, and magnetism

- Heat can be produced in many ways.
- Electricity in circuits can produce light and heat. Electrical circuits require a complete loop through which the electrical current can pass.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

Understandings about science and technology

- Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Tools help scientists make better observations, measurements, and equipment for investigation.

Science in Personal and Social Perspectives

Personal health

- Safety and security are basic needs of humans. Safety involves freedom from danger, risk, or injury.

Types of resources

- Resources are things we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources are basic materials; some are produced from basic resources (electricity), and some resources are nonmaterial (safety).
- The supply of many resources is limited. If used, resources can be extended through decreased use.

Science and technology in local challenges

- People continue inventing new ways of doing things, solving problems, and getting work done.

History and Nature of Science

Science as a human endeavor

- Science and technology have been practiced by people for a long time.
- There is still much more to be understood about science.
- Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, explanation

Constancy, change, and measurement

Form and function

Electric Circuits

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific investigations.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve experiments; and some involve seeking more information.
- Current scientific knowledge and understanding guide scientific investigations.
- Scientific explanations emphasize evidence.
- Science advances through legitimate skepticism. Asking questions and querying others' explanations is part of scientific inquiry.
- Scientific investigations sometimes result in new ideas for study or generate new methods for investigation.

Physical Science

Properties and changes in properties in matter

- Substances are often placed in categories or groups if they react in similar ways; metals (and conductors and insulators) are an example of such a group.

Transfer of energy

- Energy is a property of many substances and is associated with heat, light, and electricity. Energy is transferred in many ways.
- Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced.

Science and Technology

Abilities of technological design

- Identify appropriate problems for technological design.
- Design a solution or product.
- Implement a proposed design.
- Evaluate completed technological designs or products.
- Communicate the process of technological design.

Understandings about science and technology

- Scientific inquiry and technological design have similarities and differences. Scientists propose explanations for questions about the natural world, and engineers propose solutions relating to human problems and needs.
- Science and technology are reciprocal. Science drives technology as it addresses questions that demand more sophisticated instruments. Technology provides tools for investigation, inquiry, and analysis.
- Perfectly designed solutions do not exist. All technological solutions have trade-offs, such as safety, cost, efficiency, and appearance.
- Technological designs have constraints. Some constraints are unavoidable, for example, properties of materials; other constraints limit choices in the design, for example, human safety and aesthetics.
- Technological solutions have intended benefits and unintended consequences. Some consequences can be predicted, others cannot.

Science in Personal and Social Perspectives

Personal health

- The potential for accidents and the existence of hazards impose the need for injury prevention. Safe living involves the development and use of safety precautions.

Science and technology in society

- Science and technology have advanced through contributions of many different people, at different times in history.
- Scientists and engineers work in many different settings.
- Science cannot answer all questions and technology cannot solve all problems or meet all needs.

History and Nature of Science

Science as a human endeavor

- Women and men of various backgrounds engage in the activities of science. Some scientists work in teams and some work alone, but all communicate extensively with others.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry.

Nature of science

- Scientists formulate and test their explanations using observations and experiments.
- Different scientists might draw different conclusions from the same data. Ideally, scientists acknowledge such conflict and work towards finding evidence that will resolve their disagreement.
- It is part of scientific inquiry to evaluate the results of scientific investigations.

History of science

- Many individuals have contributed to the traditions of science. Studying some of these individuals provides further understanding of scientific inquiry and science as a human endeavor.

Unifying Concepts and Processes

Systems, order, and organization

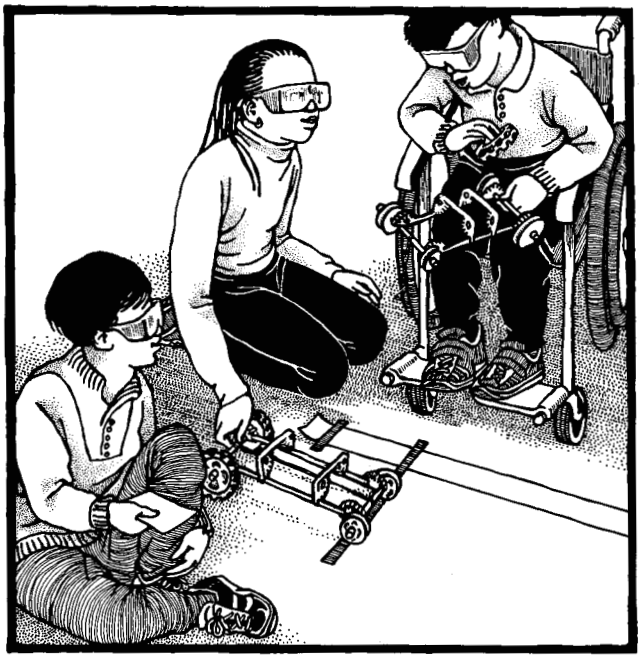
Evidence, models, and explanation

Constancy, change, and measurement

Form and function

Motion and Design

Narrative Summary



This unit invites students to explore the physics of motion and to apply these concepts to technological design. Using plastic construction materials, weights, rubber bands, and propellers, students design and build vehicles. Students record their designs using technical two-view and three-view drawings. They test how fast the vehicles move and use their findings to redesign the vehicles to move more efficiently. Cost analysis is one of the students' design requirements. As students design their vehicles, they intuitively apply concepts such as friction and kinetic and potential energy. They also explore the effect of gravity on motion. The unit concludes by challenging students to solve a design challenge and to present their findings to the class.

Science Content

This unit emphasizes the application of scientific data and concepts to technological design. As students improve on the design of their vehicles—powered by rubber bands, propellers, and dropping weights—they make use of physical science concepts of motion and forces, energy transfer, and friction. Students develop abilities to identify and state a problem, design a solution, implement a solution, and evaluate the solution. Students learn that meeting design specifications—including cost—requires trade-offs in design and function. Science as a human endeavor is central to this unit.

Assessment

In a pre-unit assessment, students share what they know and want to know about how vehicles move and are designed. Given a set of requirements, students also design and build their first vehicle using K'NEX®. These activities are matched to a post-unit assessment following Lesson 16. The unit provides many opportunities for students to make, record, and revise designs. Teachers can use these designs and technical drawings to assess students' understanding of the design process. Embedded performance-based assessments, in which students meet design challenges and apply previously collected data, are scattered throughout the unit. In Lessons 14 through 16, students are asked to reflect on what they have learned and to apply their knowledge of technological design to a more complex problem. Additional assessments at the end of the unit include a student self-assessment, an activity in which students apply conceptual knowledge of motion to design and build a vehicle, an opportunity to evaluate the function and performance of an actual vehicle, and a review of student portfolios.

Goals for *Motion and Design*

This unit provides students an opportunity to explore the physics of motion and to apply those concepts to technological design. From their experiences, students are introduced to the following concepts, skills, and attitudes.

Concepts

- A force is any push or pull on an object. An unbalanced force is needed to make a resting object move, to bring a moving object to rest, or to change the direction of a moving object.
- A force can change the speed of an object. Greater forces can change the speed of an object faster than smaller forces.
- Friction is a force that occurs when two surfaces rub together. Friction opposes motion.
- If the same force is applied to a lighter vehicle and a heavier vehicle, the speed of the lighter vehicle will change more than the speed of the heavier vehicle.
- Energy can be stored in a rubber band and released to turn an axle or spin a propeller to make a vehicle move.
- A spinning propeller exerts a force that pushes air back and moves a vehicle forward.
- Friction must be considered when a vehicle is being designed.
- Air resistance is a force that can slow the speed of a moving vehicle.
- Design requirements specify how a vehicle or other product must perform.
- Cost is often an important consideration in designing a product.
- Engineers develop, modify, and improve designs to meet specific requirements.

Skills

- Designing, building, testing, and modifying vehicles to meet design requirements.
- Building vehicles from technical two- and three-view drawings.
- Recording vehicle designs through drawing.
- Observing how an object moves and describing its motion and changes in motion.
- Measuring the time it takes a vehicle to move a given distance.
- Collecting and recording data and analyzing it to determine representative values.
- Predicting the effect of an applied force on how a vehicle moves.
- Recording and comparing distances a vehicle travels under various conditions.
- Designing a vehicle that is propelled by stored energy.
- Solving design problems using previously collected data.
- Communicating results of an investigation through record sheets, written observations, drawings, and class discussions.

Attitudes

- Recognizing the role that technological design plays in daily problem solving.
- Appreciating how science can be used to solve practical problems.
- Recognizing the importance of repeating trials to gain valid test results.
- Valuing the application of test results to future investigations.

Motion and Design

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations depending on the questions they are trying to answer.
- Simple instruments, like rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations and what they already know about the world.
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects are made from one or more materials and can be described by the materials from which they are made.

Position and motion of objects

- The position of an object can be described by locating it relative to another object.
- An object's motion can be described by tracing and measuring its position over time.
- The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

Understandings about science and technology

- Science is a way of answering questions.
- Scientists and engineers work in teams with different individuals doing different things.
- Tools help scientists make better observations.
- Women and men of all ages, backgrounds, and groups engage in the varieties of scientific and technological work.

Science in Personal and Social Perspectives

Science and technology in local challenges

- People continue inventing new ways of doing things, solving problems, and getting work done.
- Science and technology have greatly influenced transportation.

History and Nature of Science

Science as a human endeavor

- Science and technology have been practiced by people for a long time.
- Men and women have made a variety of contributions throughout the history of science and technology.

- Many people choose science as a career. Many people derive great pleasure from doing science.
- There is still much more to be understood about science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Evolution and equilibrium

Form and function

Motion and Design

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific investigations.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Understandings about scientific inquiry

- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Mathematics is important in all aspects of scientific inquiry.
- Technology used to gather data enhances accuracy and allows scientists to quantify results.
- Scientific investigations sometimes result in new ideas for study or generate new methods for investigation.

Physical Science

Motions and forces

- The motion of an object can be described by its position, direction of motion, and speed. The motion can be represented on a graph.
- An object that is not being subjected to a force will continue to move at a constant speed in a straight line.
- If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude.

Transfer of energy

- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, and sound. Energy is transferred in many ways.

Science and Technology

Abilities of technological design

- Identify appropriate problems for technological design.
- Design a solution or product.
- Implement a proposed design.
- Evaluate completed technological designs or products.
- Communicate the process of technological design.

Understandings about science and technology

- Scientific inquiry and technological design have similarities and differences. Scientists propose explanations for questions; engineers propose solutions to problems and needs.
- Science and technology are reciprocal. Technology also provides tools for investigation, inquiry, and analysis.
- Perfectly designed solutions do not exist. All solutions have trade-offs, such as cost, efficiency, and appearance.
- Technological designs have constraints, such as properties of materials or friction. Other constraints limit choice in design.

Science in Personal and Social Perspectives

Science and technology in society

- Technology influences society through its products and processes.
- Science and technology have advanced through contributions of many different people.
- Scientists and engineers work in many different settings.
- Science cannot answer all questions and technology cannot solve all problems or meet all needs.

History and Nature of Science

Science as a human endeavor

- Women and men of various backgrounds engage in the activities of science. Some scientists work in teams and some work alone, but all communicate extensively with others.
- Science requires different abilities.

Nature of science

- Scientists formulate and test their explanations using observations, experiments, and mathematical models.
- It is part of scientific inquiry to evaluate the results of scientific investigations.

History of science

- Many individuals have contributed to the traditions of science.

Unifying Concepts and Processes

Systems, order, and organization
Evidence, models, and explanation
Constancy, change, and measurement
Evolution and equilibrium
Form and function

PART 7

Science and Technology for Children™

FIFTH-GRADE UNITS

Grade	Life, Earth, and Physical Sciences and Technology			
1	Organisms	Weather	Solids and Liquids	Comparing and Measuring
2	The Life Cycle of Butterflies	Soils	Changes	Balancing and Weighing
3	Plant Growth and Development	Rocks and Minerals	Chemical Tests	Sound
4	Animal Studies	Land and Water	Electric Circuits	Motion and Design
5	**Microworlds**	**Ecosystems**	**Food Chemistry**	**Floating and Sinking**
6	Experiments with Plants	Measuring Time	Magnets and Motors	The Technology of Paper

Note: To accommodate local curriculum specifications and provide grade-level flexibility, fifth-grade STC™ units have been aligned with both the K–4 and 5–8 content standards.

Fifth-Grade STC™ Units and the NSES (5–8)

National Science Education Standards for Grades 5–8	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
Science as Inquiry				
Abilities necessary to do scientific inquiry	●	●	●	●
Understandings about scientific inquiry	●	●	●	●
Physical Science				
Properties and changes of properties in matter			●	●
Motions and forces				●
Transfer of energy	●			
Life Science				
Structure and function in living systems	●	●		
Reproduction and heredity	●	●		
Regulation and behavior	●	●		
Populations and ecosystems		●		
Diversity and adaptations of organisms	●			
Earth and Space Science				
Structure of the earth system		●		
Earth's history				
Earth in the solar system				
Science and Technology				
Abilities of technological design				●
Understandings about science and technology	●	●	●	●
Science in Personal and Social Perspectives				
Personal health		●	●	●
Populations, resources, and environments		●		
Natural hazards		●		
Risks and benefits		●	●	
Science and technology in society	●	●	●	●
History and Nature of Science				
Science as a human endeavor	●	●	●	●
Nature of science	●	●	●	●
History of science	●		●	●
Unifying Concepts and Processes				
Systems, order, and organization	●	●	●	●
Evidence, models, and explanation	●	●	●	●
Constancy, change, and measurement		●	●	●
Evolution and equilibrium		●		●
Form and function	●	●	●	●

Fifth-Grade STC™ Units and the NSES (K–4)

National Science Education Standards for Grades K–4	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
Science as Inquiry				
Abilities necessary to do scientific inquiry	●	●	●	●
Understandings about scientific inquiry	●	●	●	●
Physical Science				
Properties of objects and materials	●	●	●	●
Position and motion of objects				●
Light, heat, electricity, and magnetism	●			
Life Science				
Characteristics of organisms	●	●	●	
Life cycles of organisms	●	●		
Organisms and environments		●		
Earth and Space Science				
Properties of earth materials		●		
Objects in the sky				
Changes in earth and sky				
Science and Technology				
Abilities of technological design		●		●
Understandings about science and technology	●	●	●	●
Abilities to distinguish between natural objects and objects made by humans	●	●	●	
Science in Personal and Social Perspectives				
Personal health			●	●
Characteristics and changes in populations				
Types of resources		●	●	
Changes in environments		●		
Science and technology in local challenges	●	●	●	●
History and Nature of Science				
Science as a human endeavor	●	●	●	●
Unifying Concepts and Processes				
Systems, order, and organization	●	●	●	●
Evidence, models, and explanation	●	●	●	●
Constancy, change, and measurement		●	●	●
Evolution and equilibrium		●		●
Form and function	●	●	●	●

Microworlds

Narrative Summary

In *Microworlds*, students examine everyday objects as well as microorganisms with a variety of magnifying devices. They begin by investigating several common objects with the unaided eye. Using a variety of lenses, including hand lenses, acrylic spheres, and water drops, they learn that a magnifying lens must be transparent and curved. Next, students use a microscope to view inanimate objects. They learn proper focusing and lighting techniques, as well as how to prepare slides. Students prepare a section of onion skin and observe its cells. Students' attention then turns to living specimens. Using a microscope, they view three microorganisms—*Volvox*, *Blepharisma*, and the vinegar eel. They study the cell structure of these organisms and observe how the organisms feed, grow, and multiply. In a final challenge, students use the microscope to examine cultures they have grown from hay and grass infusions.

Science Content

This unit provides an experiential introduction to lenses, microscopes, and microorganisms. Students observe components of everyday objects and living things using simple tools. Students learn that the image of an object is magnified as light passes through transparent convex lenses. Using various hand lenses and microscopes, students extend their observations. They gain an appreciation for scientific tools and the relationships between cells and organisms. Through reading selections and direct observation, students also learn about the life cycle and habitats of microscopic organisms. As students read about Robert Hooke and Anton Leeuwenhoek, they are introduced to the invention of the microscope and the discovery of the cell.

Assessment

In Lesson 1, students engage in a pre-unit assessment in which they begin to develop their observational skills by closely examining a common object—the penny. Students also discuss what they already know and want to know about magnification, lenses, and microscopes. Following Lesson 16, a post-unit assessment is matched to the activities in Lesson 1. Two embedded assessments allow teachers to evaluate students' growth in skills and concepts. First, in Lesson 9, students attempt to identify unknown specimens—two common crystals and two non-crystals. By doing so, they apply their new skills at making well slides and at focusing on surfaces of three-dimensional objects. In Lessons 15 and 16, a second embedded assessment allows teachers to assess students' progress as students work independently to observe microbes that have developed in the hay and grass infusions they set up earlier in the unit. Additional assessments at the end of the unit include a rating scale that students can use to evaluate themselves and suggestions for evaluating student products. A teacher's record chart is included.

Goals for *Microworlds*

In this unit, students investigate both living and nonliving specimens with a variety of magnifiers, including the microscope. Their experiences introduce them to the following concepts, skills, and attitudes.

Concepts

- In order to magnify, a lens must be transparent and curved.
- Magnification is directly related to how much a lens is curved.
- Higher magnification reveals more detail in a smaller area of a specimen being observed.
- In light microscopes, lenses are combined to focus light and increase magnification.
- Scientists designed and used early microscopes to extend their observational ability and to investigate their ideas.
- Some living organisms are too small to see without magnification.
- All living things are made of at least one cell.
- When magnified, all cells have observable structures.
- Microorganisms are widespread in nature.
- Bacteria are partly responsible for the decomposition of organic material over time.
- Some bacteria are eaten by other microorganisms.
- Like all organisms, microorganisms grow and reproduce.
- Microorganisms have structures that help them survive in specific environmental conditions.
- Changing environmental conditions promote the survival of some microorganisms over others and therefore change microbial communities.

Skills

- Determining which of various objects can magnify.
- Using magnifiers, including hand lenses and microscopes, to observe living and non-living specimens.
- Using appropriate equipment and techniques to prepare microscope slides for viewing.
- Using a microscope to observe basic cell structure.
- Communicating detailed observations through writing, drawing, and discussion.
- Making measurements of small objects using hair-widths and millimeters.
- Exploring ways to slow the movement of living microscopic specimens for closer observation.

Attitudes

- Developing an interest in exploring microscopic specimens.
- Recognizing that microorganisms have many of the same needs as other living things.
- Developing an awareness of the diversity and complexity of microbial life.
- Developing an awareness of the interactions among living things and between living things and their environment.

GRADE 5

Microworlds

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, and events; some involve collecting specimens; and some involve discovery of new objects.
- Current scientific knowledge and understanding guide scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.
- Science advances through legitimate skepticism.
- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data. All of these results can lead to new investigations.

Physical Science

Transfer of energy

- Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object—emitted by or scattered from it—must enter the eye.

Life Science

Structure and function in living systems

- Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include cells and tissues.
- All organisms are composed of cells—the fundamental unit of life. Most organisms are single cells; other organisms are multicellular.
- Cells carry on the many functions needed to sustain life. They grow and divide, thereby producing more cells. This requires that they take in nutrients.

Reproduction and heredity

- Reproduction is characteristic of all living systems. Some organisms reproduce asexually.

Regulation and behavior

- All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions.
- Behavior is one kind of response an organism can make to an internal or environmental stimulus.

Diversity and adaptations of organisms

- Millions of species of animals, plants, and microorganisms are alive today.

Science and Technology

Understandings about science and technology

- Many different people in different cultures have made and continue to make contributions to science and technology.
- Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments.
- Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as size.

Science in Personal and Social Perspectives

Science and technology in society

- Science influences society through its knowledge and world view.
- Technology influences society through its products and processes.
- Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.

History and Nature of Science

Science as a human endeavor

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields such as the health professions. Some scientists work in teams, and some work alone, but all communicate extensively with others.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry.

Nature of science

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.
- Different scientists might draw different conclusions from the same data.

History of science

- Many individuals have contributed to the traditions of science.
- In historical perspective, science has been practiced by different individuals in different cultures.
- Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently take for granted.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Form and function

GRADE 5

Microworlds

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations depending on the questions they are trying to answer. Types of investigations include describing objects, events, and organisms.
- Simple instruments, such as magnifiers and rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools.
- Objects are made of one or more materials and can be described by the properties of the materials from which they are made.

Light, heat, electricity, and magnetism

- Light travels in a straight line until it strikes an object. Light can be reflected by a mirror, refracted by a lens, or absorbed by the object.

Life Science

Characteristics of organisms

- Organisms have basic needs. The world has many different environments, and distinct environments support the life of different types of organisms.
- Each plant or animal has different structures that serve different functions in growth, survival, and reproduction.
- The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as change in the environment).

Life cycles of organisms

- Plants and animals have life cycles that include being born, developing into adults, reproducing, and eventually dying.

Science and Technology

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Abilities to distinguish between natural objects and objects made by humans

- Some objects occur in nature while others have been designed by people to solve human problems.

Science in Personal and Social Perspectives

Science and technology in local challenges

- People continue inventing new ways of doing things and solving problems.
- Science and technology have greatly improved food quality and quantity, transportation, health, sanitation, and communication. These benefits of science and technology are not available to all of the people of the world.

History and Nature of Science

Science as a human endeavor

- There is still much more to be understood about science.
- Many people choose science as a career. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Form and function

Ecosystems

Narrative Summary

Students begin the unit by setting up a terrarium in which they grow grass, mustard, and alfalfa plants. They then add crickets and isopods. They also set up an aquarium into which they introduce snails, guppies, elodea, algae, and duckweed. By connecting the terrarium and aquarium bottles to create an "ecocolumn," students are able to observe the relationship between the two environments and the organisms living within them. Using test ecocolumns that contain only plants, students simulate the effects of pollutants—such as road salt, fertilizer, and acid rain—on an environment. Students then use a food chain wheel to make inferences about the effects these pollutants might have on their own miniature ecosystems. Later, students read about, explore, and discuss the Chesapeake Bay as a model ecosystem. They analyze this ecosystem from the viewpoint of various users—waterman, dairy farmer, land developer, recreational boater, and resident—and present their findings to the class. This activity enables students to appreciate the trade-offs that must be made to reach mutually acceptable solutions to environmental problems.

Science Content

Ecosystems helps students understand the relationships between plants and animals and the interdependence of living things within an environment. By modeling complex systems, students investigate the relationships between life and earth sciences while simultaneously exploring science in personal and social perspectives. As students observe the structure and function of model ecosystems, they grapple with the effects of pollutants, overpopulation, and natural hazards on these systems. Working in teams, students design and test the effects of pollutants created by humans and examine the roles of people in a real-world ecosystem—the Chesapeake Bay. Unifying concepts and processes are central to this unit as students use their models as evidence on which to base their conclusions. Extensive reading selections provide additional information on many of the organisms and concepts covered in the unit.

Assessment

Matched pre- and post-unit assessments in which students analyze relationships in a riverbank ecosystem give teachers information about what students already know about ecosystems and what they have learned by the close of the unit. Teachers are given guidance on how to assess students as they develop and perform experiments, record observations, and make presentations. Two self-assessments in the unit allow students to reflect on their own learning and examine their attitudes toward the study of ecosystems. Additional assessments at the close of the unit allow students to apply their learning to new situations. They include an activity in which students read about an environmental problem, evaluate the differing points of view, and take a stand on the issue.

Goals for *Ecosystems*

In this unit, students explore the web of relationships that link organisms to each other and to their natural environment. From their experiences, they develop an understanding of the following concepts, skills, and attitudes.

Concepts

- An ecosystem is a community of organisms and its interaction with its environment.
- Organisms can be categorized by the functions they serve in an ecosystem: producers, consumers, or decomposers.
- Organisms in an ecosystem have dependent and interdependent relationships, which can be illustrated by food webs.
- Factors that affect growth and reproduction of organisms in an ecosystem include light, water, temperature, and soil.
- Natural and human-made events can "disturb" an ecosystem.
- A pollutant is anything that can harm living organisms when too much of it is released into an ecosystem. Pollution is the condition that results when pollutants interact with the environment.
- Pollutants can affect the stability of an ecosystem; solutions can be developed to minimize or alleviate the effects of pollutants.
- Model ecosystems can be used to learn more about the complex relationships that exist on earth.

Skills

- Using a hand lens, pH paper, measuring devices, and other testing equipment appropriately.
- Conducting, recording, and organizing daily observations.
- Planning, implementing, and analyzing experiments and drawing conclusions from the results.
- Making and testing predictions.
- Identifying ecosystems as stable or disturbed and recognizing whether the causes of a disturbed ecosystem are natural or human-made.
- Reading for more information about ecosystems and pollution.
- Communicating information through writing, drawing, and discussion.
- Applying previously learned information to analyze a problem and suggest solutions.

Attitudes

- Developing sensitivity toward living things and understanding that human behavior can positively or negatively affect them.
- Respecting evidence from an experiment and recognizing that evidence can inform a decision.
- Developing an interest in investigating ecosystems.
- Recognizing the importance of repeating experiments to get valid test results.

GRADE 5

Ecosystems

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations.
- Current scientific knowledge and understanding guide scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.
- Science advances through legitimate skepticism.
- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data.

Life Science

Structure and function in living systems

- Living systems at all levels of organization demonstrate the complementary nature of structure and function, including the structure of ecosystems.
- Most organisms are single cells; other organisms are multicellular.

Reproduction and heredity

- Reproduction is characteristic of all living systems and is essential to the continuation of the species.

Regulation and behavior

- All organisms must be able to grow, reproduce, and maintain a relatively stable internal environment while living in a constantly changing external environment.
- Behavior is one kind of response an organism can make to an internal or environmental stimulus.

Populations and ecosystems

- A population consists of all individuals of a species that occur together in a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.
- Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some microorganisms are producers—they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.
- For ecosystems, the major source of energy is sunlight, which passes from organism to organism in food webs.
- The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition.

Earth and Space Science

Structure of the earth system

- Soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria.
- Water is a solvent. As it passes through the water cycle, it dissolves minerals and gases and carries them to the oceans.
- Living organisms have played many roles in the earth system.

Science and Technology

Understandings about science and technology

- Perfectly designed solutions do not exist; all solutions have trade-offs.
- Technological designs have constraints.
- Technological solutions have intended benefits and unintended consequences.

Science in Personal and Social Perspectives

Personal health

- Safe living involves the development and use of safety precautions and the recognition of risk in personal decisions.
- Natural environments may contain substances that are harmful to human beings. Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air.

Population, resources, and environments

- When an area becomes overpopulated, the environment will become degraded due to the increased use of resources.
- Causes of environmental degradation and resource depletion may vary.

Natural hazards

- Human activities can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal. Such activities can accelerate many natural changes.

Risks and benefits

- Students should understand the risks associated with natural hazards, with chemical hazards (such as pollutants), and with social hazards (transportation).
- Risks and benefits relate directly to personal and social dimensions.
- Important personal and social decisions are made based on perception of benefits and risks.

Science and technology in society

- Science influences society through its knowledge and world view. Scientific knowledge and the procedures used by scientists influence the way many individuals in society think about themselves, others, and the environment.
- Societal challenges often inspire questions for scientific research.
- Science cannot answer all questions and technology cannot solve all human problems or meet all human needs.

History and Nature of Science

Science as a human endeavor

- Some scientists work in teams, and some work alone, but all communicate extensively with one another.
- Science requires different abilities, human qualities, and habits of the mind.

Nature of science

- Scientists formulate and test their explanations using observation, experiments, and models. Scientists do and have changed their ideas when led to do so by experimental evidence.
- Different scientists might publish conflicting experimental results or might draw different conclusions from the same data.
- It is part of scientific inquiry to evaluate the results of investigations, experiments, observations, models, and explanations proposed by other scientists.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Evolution and equilibrium

Form and function

GRADE 5

Ecosystems

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances.
- Objects are made of one or more materials and can be described by the properties from which they are made.

Life Science

The characteristics of organisms

- Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light.
- Each plant or animal has different structures that serve different functions in growth, survival, and reproduction.
- The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as change in the environment).

Life cycles of organisms

- Plants and animals have life cycles that include being born, developing into adults, reproducing, and eventually dying.
- Plants and animals closely resemble their parents.
- Many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual's interactions with the environment.

Organisms and their environments

- All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.
- An organism's patterns of behavior are related to the nature of that organism's environment, including the kinds and numbers of other organisms present, the availability of food and resources, and the physical characteristics of the environment. When the environment changes, some plants and animals survive and reproduce, and others die or move to new locations.
- All organisms cause changes in the environment where they live. Some of these changes are detrimental to the organism or other organisms, whereas others are beneficial.

- Humans depend on their natural and constructed environments. Humans change environments in ways that can be either beneficial or detrimental for themselves and other organisms.

Earth and Space Science

Properties of earth materials

- Earth materials are solid rocks and soils, water, and the gases of the atmosphere; these materials have different physical properties. Earth materials provide many of the resources that humans use.
- Soils have properties of color and texture, capacity to retain water, and ability to support the growth of many kinds of plants.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

Understandings about science and technology

- Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Tools help scientists make better observations, measurements, and equipment for investigations.

Abilities to distinguish between natural objects and objects made by humans

- Some objects occur in nature while others have been designed by people to solve human problems.
- Objects can be categorized into two groups, natural and designed.

Science in Personal and Social Perspectives

Types of resources

- Resources are things we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources include basic materials, such as air, water, and soil; some are produced from basic resources; and some resources are nonmaterial, such as quiet places and beauty.
- The supply of many resources is limited. If used, resources can be extended through recycling and decreased use.

Changes in environments

- Environments are the space, conditions, and factors that affect an individual's and a population's ability to survive and their quality of life.
- Changes in environments can be natural or influenced by humans.
- Some environmental changes occur slowly, and others occur rapidly.

Science and technology in local challenges

- People continue inventing new ways of doing things and solving problems.

History and Nature of Science

Science as a human endeavor

- There is still much more to be understood about science.
- Many people choose science as a career. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Evolution and equilibrium

Form and function

Food Chemistry

Narrative Summary

In *Food Chemistry*, students explore basic concepts related to food and nutrition. They set up their own classroom laboratory and perform physical and chemical tests to identify the presence of starch, glucose, fats, and proteins in common foods. Some of the tests are relatively simple and produce "yes-or-no" results; others require multiple steps. Still other tests, such as the glucose test, produce results that require interpretation. Through readings, students discover how proteins, fats, and carbohydrates, as well as vitamins, are related to good health. They also learn how to interpret food labels. In a final challenge, students apply their knowledge and skills to analyze the nutritional components of a marshmallow.

Science Content

This physical science unit allows students to explore chemistry in a familiar context. The unit emphasizes the transfer of energy in biological systems and the nutrition of common foods. Students have opportunities to gather, organize, and interpret data throughout this unit. They discover that scientific inquiry can provide useful information about nutrients and foods. Through making predictions, conducting tests, analyzing results, and discussing findings with classmates, students become engaged in processes that encourage problem solving and foster the understanding that scientific conclusions must be justified by evidence. Reading selections about vitamins reveal both their importance in nutrition and in the history of health and science.

Assessment

Lesson 1 serves as a pre-unit assessment. By brainstorming what they know and want to know about foods and discussing foods they eat for specific meals, students begin to consider the relationship of nutrition to health. In the post-unit assessment, the class revisits these questions, providing the teacher with two sets of comparable data that indicate students' growth in knowledge and skills. Lesson 16 is an embedded assessment in which students apply the testing techniques they have learned in the unit to determine the nutritional value of a marshmallow. Additional assessments at the close of the unit include a student self-assessment, a performance-based assessment in which students identify mystery foods using tests from the unit, and an activity in which students read and interpret sample food labels.

Goals for *Food Chemistry*

In this unit, students investigate the basic nutrients found in a variety of common foods. From their experiences, they are introduced to the following concepts, skills, and attitudes.

Concepts

- Foods contain starches, sugars, fats, and/or proteins.
- Specific chemical and physical tests can be used to determine whether a food contains starches, sugars (in this unit, glucose), fats, or proteins.
- Iodine can be used to test for starches, test strips for glucose, brown paper for fats, and Coomassie blue for proteins.
- Varying amounts of starches, sugars (in this unit, glucose), fats, and proteins are found in foods.
- Starches and sugars are carbohydrates.
- Glucose is one kind of sugar.
- Carbohydrates, fats, proteins, water, vitamins, and minerals are nutrients.
- Nutrients are essential to human health.

Skills

- Learning to perform four chemical and physical tests to identify the presence or absence of nutrients in foods.
- Predicting the nutrient content of foods.
- Conducting independent research on nutrients.
- Observing, recording, and organizing test results.
- Interpreting a range of test results to draw conclusions about the kinds and amounts of nutrients in foods.
- Developing laboratory techniques to avoid contamination of the test samples.
- Communicating results in writing and through discussion.
- Reflecting on experiences in writing and through discussion.
- Applying previously learned concepts and skills to solve a problem.

Attitudes

- Developing an interest in investigating the nutritional content of food.
- Recognizing the importance of repeating tests to validate results.
- Recognizing that nutritional information can be used to make informed decisions about the foods we eat.

GRADE 5

Food Chemistry

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations.
- Current scientific knowledge and understanding guide scientific investigations.
- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.
- Science advances through legitimate skepticism.
- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data.

Physical Science

Properties and changes of properties in matter

- A substance has characteristic properties, such as solubility.
- Substances react chemically in characteristic ways with other substances.

Science and Technology

Understandings about science and technology

- Many different people in different cultures have made and continue to make contributions to science and technology.
- Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as quantity. Technology also provides tools for investigations, inquiry, and analysis.

Science in Personal and Social Perspectives

Personal health

- Regular exercise is important to the maintenance and improvement of health. The benefits of physical fitness include maintaining healthy weight, having energy and strength for routine activities, good muscle tone, bone strength, strong heart/lung systems, and improved mental health.
- Food provides energy and nutrients for growth and development. Nutrition requirements vary with body weight, age, sex, activity, and body functioning.

Risks and benefits

- Risk analysis considers the type of hazard and estimates the number of people that might be exposed and the number likely to suffer consequences. The results are used to determine the options for reducing or eliminating risks.
- Students should understand the risks associated with chemical hazards (food), biological hazards (viruses, bacteria), and with personal hazards (diet).
- Individuals can use a systematic approach to thinking critically about risks and benefits.
- Important personal and social decisions are made based on perceptions of benefits and risks.

Science and technology in society

- Science influences society through its knowledge and world view.
- Societal challenges often inspire questions for scientific research.
- Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact.
- Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.
- Scientists and engineers work in many different settings, including colleges and universities, businesses and industries, research institutes, and government agencies.
- Science cannot answer all questions and technology cannot solve all human problems or meet all human needs.

History and Nature of Science

Science as a human endeavor

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields such as the health professions.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry.

Nature of science

- Scientists formulate and test their explanations of nature using observation and experiments.
- It is normal for scientists to differ with one another about the interpretation of the evidence.
- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, and the explanations proposed by other scientists.

History of science

- Many individuals have contributed to the traditions of science.
- In historical perspective, science has been practiced by different individuals in different cultures.
- Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently take for granted.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Form and function

GRADE 5

Food Chemistry

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations, depending on the questions they are trying to answer.
- Simple instruments, such as magnifiers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
- Scientists make the results of their investigation public.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools.
- Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.

Life Science

Characteristics of organisms

- Organisms have basic needs, such as food and water.

Science and Technology

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Abilities to distinguish between natural objects and objects made by humans

- Some objects occur in nature; others have been designed and made by people to solve human problems and enhance the quality of life.

Science in Personal and Social Perspectives

Personal health

- Safety and security are basic needs of humans. Safety involves freedom from danger, risk, or injury. Student understandings include following safety rules for home and school, preventing neglect, and avoiding injury.
- Individuals have some responsibility for their own health.
- Nutrition is essential to health. Students should understand how the body uses food and how various foods contribute to health. Recommendations for good nutrition include eating a variety of foods, eating less sugar, and eating less fat.
- Students should understand that some substances, such as prescription drugs, can be beneficial, but that any substance can be harmful if used inappropriately.

Types of resources

- Resources are things we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources are basic materials and some are produced from basic resources, such as food.

Science and technology in local challenges

- People continue inventing new ways of doing things, solving problems, and getting work done.
- Science and technology have greatly influenced food quality.

History and Nature of Science

Science as a human endeavor

- Science and technology have been practiced by people for a long time.
- Men and women have made a variety of contributions throughout the history of science and technology.
- Although men and women using scientific inquiry have learned much about the objects, events, and phenomena in nature, much more remains to be understood.
- Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Form and function

Floating and Sinking

Narrative Summary

In this unit, students investigate the phenomenon of buoyancy. They begin by making a spring scale with which they weigh various objects. They make clay boats, test their boats' buoyancy, and discover that altering the shape of the boats affects buoyancy. Students are then challenged to design a boat that has a certain loading capacity. These experiments allow them to witness several surprising phenomena; for example, some "floaters" are heavier than some "sinkers," and large objects are not always heavier than smaller objects. Students then turn their attention to differences between objects placed in fresh water and in salt water. They construct a hydrometer that compares the levels at which objects float in both types of water.

Science Content

This unit emphasizes the unifying concepts of evidence, models, and measurement. Model building allows students to engage in the process of technological design. Using models, the students have multiple opportunities to investigate floating and sinking. These experiences introduce students to physical science concepts such as buoyancy and force. Structured and open-ended explorations provide meaningful experiences and data for students to evaluate as they continue to explore and refine their models. The model-building processes not only help students improve their understanding of floating and sinking but also enrich their understanding of the process of scientific inquiry.

Assessment

During a pre-unit assessment in Lesson 1, students share what they know and want to know about why objects sink or float. They then observe an object in two containers of water, one in which the object floats and the other in which the object sinks. Students record their observations and ideas about how this could happen. To assess growth in understanding, students revisit this same question and investigation in a post-unit assessment. In an embedded assessment, students construct a scientific instrument—the hydrometer—and compare the level at which it floats in graduated cylinders of fresh water and salt water. By observing students doing this activity, teachers can assess students' understanding of buoyant force and displacement. In a final embedded assessment, students make and test predictions about an unknown "mystery cylinder." In doing so, they are challenged to apply what they have learned from their previous experiences with buoyancy. Additional assessments at the end of the unit include a student self-assessment, a questionnaire for students on why objects float or sink, and a performance-based assessment in which students are challenged to make a cylinder with unknown contents float.

Goals for *Floating and Sinking*

In this unit, students investigate the phenomenon of buoyancy. From their experiences, they are introduced to the following concepts, skills, and attitudes.

Concepts

- Several variables affect the buoyancy of an object.
- Water pushes up on both floating and submerged objects with a buoyant force; objects push down on the water.
- The buoyant force on large objects is greater than the buoyant force on smaller objects.
- The amount of water an object displaces is directly related to the object's volume.
- Because of buoyant force, objects appear to weigh less when they are submerged.
- Objects that weigh more than the same volume of water sink; objects that weigh less than the same volume of water float.
- Salt water weighs more than an equal amount of fresh water.
- The buoyancy of an object varies with the density of the liquid.

Skills

- Observing, recording, and organizing test results.
- Applying previous experiences to make predictions.
- Creating and analyzing graphs.
- Calibrating a spring scale and using it to measure the magnitude of a force.
- Reading science materials for information.
- Communicating results through writing and discussion.
- Solving a problem that requires the application of previously learned concepts and skills.

Attitudes

- Developing an interest in investigating floating, sinking, and related phenomena.
- Recognizing the importance of repeating a test or measurement and comparing results.

GRADE 5

Floating and Sinking

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific inquiry.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects or organisms; some involve experiments; and some involve discovery of new objects.
- Mathematics is important in all aspects of scientific inquiry.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.

Physical Science

Properties and changes of properties in matter

- A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample.

Motion and forces

- If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude.

Science and Technology

Abilities of technological design

- Identify appropriate problems for technological design.
- Design a solution or product.
- Implement a proposed design.
- Evaluate completed technological designs or products.

Understandings about science and technology

- Scientists propose explanations for questions about the natural world, and engineers propose solutions relating to human problems, needs, and aspirations.
- Many different people in different cultures have made and continue to make contributions to science and technology.
- Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique.
- Perfectly designed solutions do not exist; all solutions have trade-offs.

Science in Personal and Social Perspectives

Personal health

- Safe living involves the development and use of safety precautions and the recognition of risk in personal decisions. Injury prevention has personal and social dimensions.

Science and technology in society

- Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.

History and Nature of Science

Science as a human endeavor

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields. Some scientists work in teams, others alone, but all communicate with one another.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry. Science is very much a human endeavor and relies on human qualities and habits of the mind.

Nature of science

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Scientists change their ideas when led to do so by experimental evidence.
- Different scientists might draw different conclusions from the same data.
- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, and observations.

History of science

- Many individuals have contributed to the traditions of science.
- In historical perspective, science has been practiced by different individuals in different cultures.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Evolution and equilibrium

Form and function

GRADE 5

Floating and Sinking

Fundamental Concepts and Principles Addressed (K–4)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Understandings about scientific inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations depending on the questions they are trying to answer.
- Simple instruments, such as rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.
- Scientists make the results of their investigations public.
- Scientists review and ask questions about the results of other scientists' work.

Physical Science

Properties of objects and materials

- Objects have many observable properties, including size, weight, shape, color, and the ability to react with other substances. Those properties can be measured using tools, such as rulers and balances.
- Objects are made of one or more materials and can be described by the properties of the materials from which they are made.

Position and motion of objects

- The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.

Science and Technology

Abilities of technological design

- Identify a simple problem.
- Propose a solution.
- Implementing proposed solutions.
- Evaluate a product or design.
- Communicate a problem, design, and solution.

Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things they could not otherwise see, measure, and do.

Science in Personal and Social Perspectives

Personal health

- Safety and security are basic needs of humans. Safety involves freedom from danger, risk, or injury. Student understandings include following safety rules for home and school.

Science and technology in local challenges

- People continue inventing new ways of doing things and solving problems.

- Science and technology have greatly improved transportation and health. These benefits of science and technology are not available to all of the people of the world.

History and Nature of Science

Science as a human endeavor

- Science and technology have been practiced by people for a long time.
- Men and women have made a variety of contributions throughout the history of science and technology.
- Much more remains to be understood about science. Science will never be finished.
- Many people derive great pleasure from doing science.

Unifying Concepts and Processes

Systems, order, and organization
Evidence, models, and explanation
Constancy, change, and measurement
Evolution and equilibrium
Form and function

PART 8

Science and Technology for Children™

SIXTH-GRADE UNITS

Grade	Life, Earth, and Physical Sciences and Technology			
1	Organisms	Weather	Solids and Liquids	Comparing and Measuring
2	The Life Cycle of Butterflies	Soils	Changes	Balancing and Weighing
3	Plant Growth and Development	Rocks and Minerals	Chemical Tests	Sound
4	Animal Studies	Land and Water	Electric Circuits	Motion and Design
5	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
6	**Experiments with Plants**	**Measuring Time**	**Magnets and Motors**	**The Technology of Paper**

Sixth-Grade STC™ Units and the NSES (5–8)

National Science Education Standards for Grades 5–8	Experiments with Plants	Measuring Time	Magnets and Motors	The Technology of Paper
Science as Inquiry				
Abilities necessary to do scientific inquiry	●	●	●	●
Understandings about scientific inquiry	●	●	●	●
Physical Science				
Properties and changes of properties in matter			●	●
Motions and forces		●	●	
Transfer of energy		●	●	
Life Science				
Structure and function in living systems	●			
Reproduction and heredity	●			
Regulation and behavior	●		●	
Populations and ecosystems				
Diversity and adaptations of organisms	●			
Earth and Space Science				
Structure of the earth system				
Earth's history				
Earth in the solar system	●	●		
Science and Technology				
Abilities of technological design		●	●	●
Understandings about science and technology		●	●	●
Science in Personal and Social Perspectives				
Personal health			●	
Populations, resources, and environments				
Natural hazards				●
Risks and benefits				
Science and technology in society		●	●	●
History and Nature of Science				
Science as a human endeavor	●	●	●	●
Nature of science	●	●	●	●
History of science	●	●	●	●
Unifying Concepts and Processes				
Systems, order, and organization	●	●	●	
Evidence, models, and explanation	●	●	●	●
Constancy, change, and measurement	●	●	●	●
Evolution and equilibrium				
Form and function	●	●	●	●

Experiments with Plants

Narrative Summary

In this unit, students apply the knowledge and skills they have gained in earlier STC™ life science units to investigate some of the variables that affect plant growth and development. The main objective of the unit is to enable students to design and conduct a controlled experiment. They begin by studying the key variables that affect the life, health, and reproduction of the Wisconsin Fast Plant™ *(Brassica rapa)* and how they can manipulate these variables. Working in teams, students formulate a question about the plant and carry out a controlled experiment designed to answer that question. During the ensuing weeks, they observe the plants and record their data. Each team then shares its results with the class. Final activities entail germinating seeds that students have gathered from the plants and exploring tropisms.

Science Content

The key concepts of this life science unit are identifying, controlling, and manipulating variables in experimentation. The unit emphasizes how to formulate questions, use scientific methods and procedures, analyze findings, and report results. Students learn about the structure and function of plants and plant ecology, and they conduct experiments involving germination and tropism. The germination experiments are designed to help students appreciate the continuous nature of the life cycle. Throughout the unit, students are encouraged to find their own answers by experimenting and using resource materials. Mathematics in science, the abilities necessary to long-term scientific inquiry, and the nature of science are integral to this unit.

Assessment

This unit begins with a pre-unit assessment in which students brainstorm what they know about carrying out an experiment. To enable teachers to evaluate students' knowledge of controlling variables, students also discuss what it means to have a fair race. In the final part of the pre-unit assessment, students create labeled drawings of flowering plants. These activities are matched to a post-unit assessment following Lesson 16. Throughout the unit, students have several opportunities to evaluate and revise their own work in planned investigations before they design and carry out their own study. Their final project in written or oral form can be used as a culminating embedded assessment. Additional assessments at the end of the unit include a teacher's record chart of student progress. It allows teachers to assess each student's work products, concepts, and skills developed in the unit. Students can use a rating scale to conduct a self-assessment.

Goals for *Experiments with Plants*

In this unit, students plan and conduct experiments to determine how different variables affect the growth and seed production of rapid-cycling *Brassica rapa* (Wisconsin Fast Plants™). Their experiences introduce them to the following concepts, skills, and attitudes.

Concepts

- Plants need soil nutrients, light, and water.
- Plant growth is affected by the quantities of nutrients, light, and water available.
- Controlling variables enables the effect of each to be identified and studied.
- Flowering plants must be pollinated in order to produce seeds.
- Bees are effective pollinators.
- One seed has the potential to produce one plant.
- The number of seeds produced by a single plant is affected by such variables as nutrients, light, water, and the extent of pollination.
- The orientation of a plant's growth is affected by gravity and light.

Skills

- Planting and caring for plants.
- Predicting how changing one variable might affect the outcome of an experiment.
- Planning and conducting experiments in which variables are controlled.
- Observing, measuring, describing, and recording changes in plant growth.
- Communicating results through graphs, drawings, and group presentations.
- Interpreting and analyzing how different variables affect the growth and change of plants over time.
- Reflecting on experiences through writing and discussion.
- Reading and researching to learn more about plants.

Attitudes

- Developing an interest in investigating plant growth.
- Appreciating the need for careful and precise design of experiments.
- Appreciating the need for detailed recordkeeping during experimentation.
- Valuing scientific data that has been collected over time.

GRADE 6

Experiments with Plants

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific inquiry.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations.
- Current scientific knowledge and understanding guide scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.
- Science advances through legitimate skepticism.
- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for investigation, or develop new technologies to improve the collection of data.

Life Science

Structure and function of living systems

- Living systems demonstrate the complementary nature of structure and function.
- Cells carry on many functions needed to sustain life. Cells take in nutrients, which they use to provide energy or make the materials that a cell or an organism needs.

Reproduction and heredity

- Reproduction is characteristic of all living systems and is essential to the continuation of every species.
- Plants reproduce sexually with the egg and sperm produced in the flowers of flowering plants.
- The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited and others result from interactions with the environment.

Regulation and behavior

- All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.
- Behavior is one kind of response an organism can make to an internal or environmental stimulus.

Diversity and adaptations of organisms

- Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations.

Earth and Space Science

Earth in the solar system

- The sun is a major source of energy for such phenomena as growth of plants.

History and Nature of Science

Science as a human endeavor

- Some scientists work in teams, others alone, but all communicate with one another.
- Science requires different abilities, human qualities, and habits of the mind.

Nature of science

- Scientists formulate and test their explanations of nature using observation, experiments, and models. Scientists change their ideas when led to do so by experimental evidence.
- Different scientists might publish conflicting experimental results or might draw different conclusions from the same data. Ideally, scientists acknowledge such conflict and work towards finding evidence that will resolve their disagreement.
- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, models, and explanations proposed by other scientists.

History of science

- Many individuals have contributed to the traditions of science.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Form and function

Measuring Time

Narrative Summary

In the first part of this unit, "Keeping Time with the Sun and the Moon," students explore the use of natural phenomena, such as the phases of the moon, to keep time. In the second section, "Investigating Invented Clocks," students conduct experiments using some of the instruments that have been used to keep time throughout the centuries. They build and experiment with a water clock and investigate the characteristics of the pendulum. Finally, they apply what they have learned to assemble and evaluate a clock escapement and modify the device in order to make it more accurate. The unit provides students with an opportunity to learn how to measure time, to investigate machines, to explore concepts such as energy and motion, and to learn about the science of astronomy.

Science Content

Students engage in active and extended scientific inquiry as they construct water clocks; assemble, troubleshoot, and improve a working clock escapement; and engage in other activities related to measuring time. Students learn that time can be measured by observing the cycles of the sun and moon, and that mechanical devices can be constructed to measure intervals of time. The processes of technological design are addressed as students design, implement, evaluate, and communicate the processes of designing a water clock, pendulum, clock escapement, and one-minute timer. Classroom investigations enable them to appreciate that the accuracy of such instruments depends on an appropriate design. Students plan and conduct experiments involving controlled variables and experience the challenges typically faced by scientists and engineers. Reading selections and lesson objectives demonstrate the degree to which the history of timekeeping is integral to the unit.

Assessment

Assessment strategies include examination of matched student pre- and post-unit assessments, written student self-assessments, and student record sheets, graphs, and drawings, as well as observations of growth in scientific skills and contributions to class discussions. An embedded assessment in Lesson 16, in which students design and build their own one-minute timer, provides information on students' ability to apply what they have learned about timekeeping devices. Additional assessments at the end of the unit challenge students to respond, orally or in writing, to questions that are based on unit investigations of clocks and to make predictions about the changing appearance of the moon.

Goals for *Measuring Time*

In this unit, students investigate the history of timekeeping and experiment with various timekeeping devices. From their experiences, they are introduced to the following concepts, skills, and attitudes.

Concepts

- Time can be measured by observing the natural cycles of the sun and the moon.
- Shadows cast by the sun can be used to measure and predict the passage of time during a day.
- The phases of the moon follow a cycle that can be used to measure and predict the passage of time during a month.
- Mechanical devices can be constructed and used to measure specific intervals of time consistently.
- The accuracy of mechanical clocks is dependent on their design, the materials from which they are constructed, and their energy source.

Skills

- Observing and recording information about the natural cycles of the sun and the moon.
- Learning to plan and conduct experiments in which variables are controlled.
- Predicting and testing how changing a variable affects the outcome of an experiment.
- Interpreting test results to draw conclusions about how changing variables affects the outcome of an experiment.
- Communicating results through writing in notebooks; organizing information in charts, tables, and graphs; and discussion.
- Reading and researching science materials for more information.
- Applying previously learned concepts and skills to solve a problem.

Attitudes

- Developing an interest in exploring and investigating time.
- Recognizing the importance of repeating tests to validate results.
- Appreciating the advances people have made in measuring time and explaining natural phenomena.

GRADE 6

Measuring Time

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific inquiry.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations.
- Current scientific knowledge and understanding guide scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.
- Science advances through legitimate skepticism.
- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data.

Physical Science

Motions and forces

- The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.

Transfer of energy

- Energy is a property of many substances. It is, for example, associated with mechanical motion.
- The sun is a major source of energy. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light and consists of visible light, infrared, and ultraviolet radiation.

Earth and Space

Earth in the solar system

- Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses.

Science and Technology

Abilities of technological design

- Identify appropriate problems for technological design.
- Design a solution or product.
- Implement a proposed design.
- Evaluate completed technological designs or products.
- Communicate the process of technological design.

Understandings about science and technology

- Many different people in different cultures have made and continue to make contributions to science and technology.
- Perfectly designed solutions do not exist. All solutions have trade-offs.

Science in Personal and Social Perspectives

Science and technology in society

- Science influences society through its knowledge and world view.
- Technology influences society through its products and processes.
- Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.

History and Nature of Science

Science as a human endeavor

- Women and men of various backgrounds engage in the activities of science. Some scientists work in teams and some work alone, but all communicate extensively with others.
- Science requires different abilities. Science is very much a human endeavor, and the work of science relies on basic human qualities and scientific habits of mind.

Nature of science

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.
- Different scientists might draw different conclusions from the same data. Ideally, scientists acknowledge such conflict and work towards finding evidence that will resolve their disagreement.
- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists.

History of science

- Many individuals have contributed to the traditions of science.
- In historical perspective, science has been practiced by different individuals in different cultures.
- Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently take for granted.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Form and function

Magnets and Motors

Narrative Summary

Magnets and Motors, which builds on the knowledge that students gained in the STC™ *Electric Circuits* unit, offers students the opportunity to explore the properties of magnets and the magnetic properties of electric currents. The unit includes information on the historical development of scientists' understanding of the use of magnetism, electricity, and electromagnetism. Students begin by studying magnets and making a compass. They then investigate the relationship between magnetism and electricity, as they explore the characteristics of switches and circuits. Finally, students experiment with three different motors. Applying their learning and experience, they dismantle, experiment with, and reassemble a manufactured motor.

Science Content

Students explore systems, organization, form, and function through their investigations of electric motors. These investigations encourage students to develop an appreciation for technology. The processes of technological design are addressed as students build and test a working electric generator. Physical science concepts include motions and forces and transfer of energy. Reading selections expand on the unit goals and cover such topics as how the earth's magnetic field affects some animals' movements. The unit mirrors the historical development of our understanding and use of magnetism, electricity, and electromagnetism and progresses through these phenomena in the same order that people discovered them—magnets and compasses, electricity from batteries, and electromagnetism (electromagnets, motors, and generators).

Assessment

Lesson 1 provides opportunities for students to take part in a pre-unit assessment brainstorming session and write and talk about what they already know about magnets and motors. It is complemented by a matched post-unit assessment. In several lessons, students produce models or diagrams or record observations that can be used to assess progress and understanding. An embedded assessment in Lesson 16 allows students to participate in an investigation that uses their new knowledge to produce a working electric generator. Additional assessments at the close of the unit include an investigation in which students build and demonstrate an electric current detector and a journal-writing exercise in which students express their ideas about how a spinning coil motor functions. Also included is an activity in which students are challenged to devise methods to measure the strength of a magnet. A teacher's record chart of student progress is included. It is a convenient way to keep a record of the progress of individual students and track the work students produce as well as the skills they develop.

Goals for *Magnets and Motors*

In this unit, students explore magnets, electromagnets, and motors. Through their experiences, students are introduced to the following concepts, skills, and attitudes.

Concepts

- Magnets attract and repel each other; this attracting and repelling can be used to cause motion.
- A compass can be constructed by suspending a magnet so that it is free to rotate.
- A compass will move in response to a magnet that is placed near it.
- An electric current moving through a wire produces magnetism; a coil of copper wire conducting an electric current becomes an electromagnet.
- A steel bolt placed inside a coil of wire conducting an electric current increases the strength of the electromagnet.
- A simple motor can be made from an electromagnet and a rotating armature.
- An electric current can be generated by placing a rotating coil of wire near a magnet.

Skills

- Observing, describing, and recording the results of experiments.
- Learning to plan and conduct experiments in which variables are controlled.
- Predicting and testing how changing a variable affects the outcome of an experiment.
- Interpreting the results of experiments to draw conclusions.
- Applying troubleshooting strategies to investigations with compasses, electromagnets, and motors.
- Reading and researching to learn more about electricity and motors.
- Communicating results through writing, drawing, and discussion.

Attitudes

- Developing an interest in experimenting with the technology of motors.
- Appreciating advances made in the use of magnets, electricity, and motors.
- Recognizing the importance of validating results through repeated testing.

GRADE 6

Magnets and Motors

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- Scientific explanations use evidence, have logically consistent arguments, and use scientific principles, models, and theories.
- Science advances through legitimate skepticism.
- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for investigation, or develop new technologies to improve the collection of data.

Physical Science

Properties and changes of properties in matter

- Substances, such as metals, are often placed in categories or groups if they react in similar ways.

Motions and forces

- The motion of an object can be described by its position, direction of motion, and speed.
- An object that is not being subjected to a force will continue to move at a constant speed.
- If more than one force acts on an object, then the forces will reinforce or cancel one another.

Transfer of energy

- Energy is a property of many substances and is associated with heat, light, electricity, and mechanical motion. Energy is transferred in many ways.
- Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced.

Life Science

Regulation and behavior

- Behavior is one kind of response an organism can make to an internal or environmental stimulus. Behavioral response is a set of actions determined in part by heredity and in part from experience.

Science and Technology

Abilities of technological design

- Implement a proposed design.
- Evaluate completed technological designs or products.

Understandings about science and technology

- Many different people have made and continue to make contributions to science and technology.
- Science and technology are reciprocal.
- Perfectly designed solutions do not exist. All solutions have trade-offs.

Science in Personal and Social Perspectives

Personal health

- The potential for accidents and the existence of hazards impose the need for injury prevention. Safe living involves the development and use of safety precautions and the recognition of risk in personal decisions. Injury prevention has social and personal dimensions.

Science and technology in society

- Science influences society through its knowledge and world view.
- Technology influences society through its products and processes.
- Science and technology have advanced through contributions of different people at different times in history.

History and Nature of Science

Science as a human endeavor

- Some scientists work in teams, and some work alone, but all communicate extensively with others.
- Science requires different abilities.

Nature of science

- Scientists formulate and test their explanations of nature using observations, experiments, and models.
- It is normal for scientists in certain situations to differ with one another about the interpretation of evidence.
- It is part of scientific inquiry to evaluate the result of scientific investigations, experiments, observations, models, and explanations proposed by others.

History of science

- Many individuals have contributed to the traditions of science.
- Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach conclusions we currently take for granted.

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Form and function

The Technology of Paper

Narrative Summary

This unit gives students an opportunity to explore the properties of paper, to make paper by hand, and to understand how the properties of paper relate to how it is used. By testing six types of paper for smoothness, tear-resistance, opacity, water-resistance, and ink receptivity, students deepen their understanding of the relationship between the properties of a certain type of paper and its intended uses. Students read about industrial papermaking and explore hand papermaking. Using the class hand-papermaking process, students investigate the role of additives and of embedding and embossing in the creating of paper with a variety of properties. In a final activity, students apply their learning and experience to work through a four-step technological design process as they create their own recycled-paper product.

Science Content

This unit fosters understanding about science, technology, and society. Students design and conduct controlled tests and support their conclusions with evidence. The activities, which culminate in an extended opportunity to use a technological design process, challenge and broaden students' skills and abilities in these areas. This unit applies the history and nature of science to the study of common papers. Students investigate the physical properties and uses of paper and apply this knowledge to design, make, and evaluate their own recycled paper product, making scientific inquiry and technological design integral to this unit.

Assessment

Lesson 1 serves as a pre-unit assessment of students' knowledge of the properties and uses of paper and allows students to share what they know and want to know about paper. A matched post-unit assessment complements this activity. An embedded assessment in Lesson 5 gives students an opportunity to share test results and write a performance summary for the papers they have tested. A student self-assessment in Lesson 8 and another at the close of the unit allow students to reflect on their experiences. Embedded assessments, in which students apply their knowledge and skills by experimenting with the class paper-recycling process and designing and making their own recycled paper product, are also included. Additional assessments at the close of the unit invite students to apply the hand-papermaking and technological design process to a new situation, demonstrate their awareness of the value of product testing and of what constitutes a "fair test," and show their understanding of the design process.

Goals for *The Technology of Paper*

In this unit, students explore the properties of paper and the science of papermaking and apply these concepts through technological design. Through their experiences, students are introduced to the following concepts, skills, and attitudes.

Concepts

- Paper is made from plant fibers such as wood, cotton, and linen.
- Some properties of paper are how opaque, absorbent, tear-resistant, and smooth it is.
- The desired use of a paper determines the importance of, and quality specifications for, each property.
- Steps in hand and machine papermaking include preparing the fiber, beating and preparing pulp, sheet forming, pressing and drying, and finishing.
- People from different cultures have made and continue to make contributions to the science and technology of paper.
- Paper is a major renewable resource.
- Steps needed to make paper from recycled paper include collecting, sorting, removing contaminants, cleaning, and deinking.
- Additives are mixed with refined pulp to give paper special properties.
- Papermaking variations include embedding and embossing.
- Steps in technological design include identifying needs and opportunities, generating a design, planning and making the product, and testing and evaluating the product.
- Technological designs have constraints that can limit design choices. Constraints can include time and availability of materials.
- Design requirements specify how a designed object must perform.
- Product designers continually modify their design specifications in order to improve the products.

Skills

- Learning to perform class paper-property tests.
- Observing, describing, and recording test results and the structural, optical, and absorptive properties of paper.
- Collecting, analyzing, and drawing conclusions from data.
- Learning to plan and conduct tests with controlled variables.
- Predicting how changing a variable affects the outcome of a controlled test.
- Supporting conclusions with reasons that are based on observation and experience.
- Developing the ability to consider different aspects of a need by researching existing products and the desires of potential users.
- Applying previously learned concepts and skills to new situations, such as designing a paper product that meets a specific need.
- Studying products and systems to develop an understanding of technology.
- Generating and comparing design ideas in light of product requirements.

- Organizing and using materials and resources to test the properties of paper, recycle paper, and design and implement a plan to make a paper product.
- Evaluating products on the basis of how well they meet design requirements and suggesting modifications to better meet the products' design specifications.
- Communicating ideas and the process of technological design through writing and discussion.
- Reading to enhance understanding of the history and technology of papermaking.

Attitudes

- Developing an interest in exploring technological design through work with everyday materials.
- Developing an understanding of and appreciation for the importance of paper in our lives.
- Developing an understanding of and appreciation for the benefits of controlled product testing.
- Appreciating the importance of recycling paper.
- Appreciating how science is applied to solve practical problems.

The Technology of Paper

Fundamental Concepts and Principles Addressed (5–8)

Science as Inquiry

Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Mathematics is used in all aspects of scientific inquiry.

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations.
- Current scientific knowledge and understanding guide scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.
- Science advances through legitimate skepticism.
- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data.

Physical Science

Properties and changes of properties in matter

- A substance has characteristic properties.

Science and Technology

Abilities of technological design

- Identify appropriate problems for technological design.
- Design a solution or product.
- Implement a proposed design.
- Evaluate completed technological designs or products.
- Communicate the process of technological design.

Understandings about science and technology

- Scientific inquiry and technological design have similarities and differences.
- Many different people in different cultures have made and continue to make contributions to science and technology.
- Science and technology are reciprocal.
- Perfect design solutions do not exist. All technological solutions have trade-offs, such as safety, cost, efficiency, and appearance.
- Technological designs have constraints.
- Technological solutions have intended benefits and unintended consequences.

Science in Personal and Social Perspectives

Natural hazards

- Human activities can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal.

Science and technology in society

- Technology influences society through its products and processes.
- Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.
- Scientists and engineers work in many different settings, including colleges and universities, businesses and industries, research institutes, and government agencies.
- Science cannot answer all questions and technology cannot solve all human problems or meet all human needs.

History and Nature of Science

Science as a human endeavor

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry.

Nature of science

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.
- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists.

History of science

- Many individuals have contributed to the traditions of science.
- In historical perspective, science has been practiced by different individuals in different cultures.
- Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently take for granted.

Unifying Concepts and Processes

Evidence, models, and explanation

Constancy, change, and measurement

Form and function