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

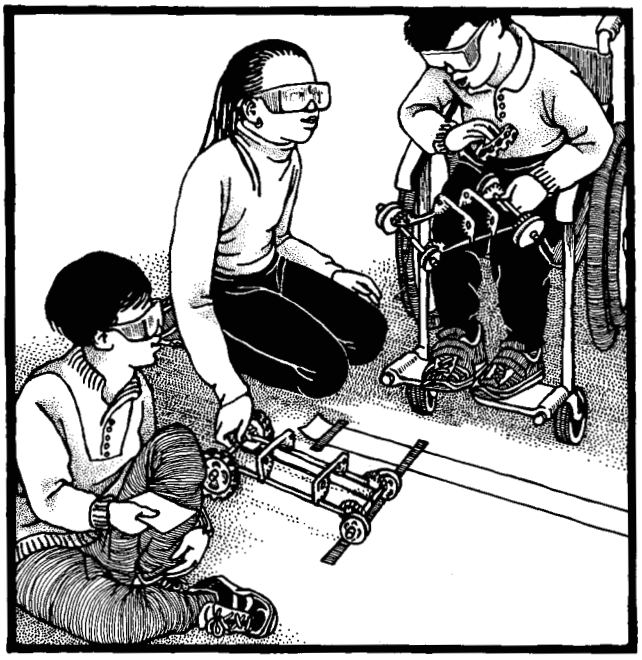
Evidence, models, and explanation

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.
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- 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