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

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Form and function