Circuits and Pathways Pacing Guide[1]

Use the information below to assist you in determining the amount of time needed to complete the entire unit. These recommendations assume the **average science class period is 50 to 60 minutes in length**. We recommend teaching science a minimum of three sessions per week in order to maintain consistency and keep students engaged. Many teachers accomplish this by rotating a science unit with a social studies unit, enabling you to teach more science sessions in one week and finish the unit in fewer weeks. We highly recommend that all teachers participate in the Expository Writing and Science Notebooks Program in order to further develop students' science understandings, as well as their scientific thinking and writing skills. To implement the science-writing curriculum requires, for most lessons, a separate 20 to 30 minutes for a science-writing mini-lesson and independent writing time. Time for these mini-lessons is not included in this pacing guide.

NOTE: Teach all lessons in the sequence given in this Pacing Guide and the Circuits and Pathways Instructional Guide.

Lessons and Common Assessments (See corresponding pages in Instructional Guide for lesson plan.)	**Recommended Number of Periods**	**GLEs Addressed/Big Ideas of the Lesson**	**Considerations for Planning**	**Recommended Applications and Extensions**
Learning Experience 2: Circuits and Motors Students focus on the elements of a complete circuit by exploring different ways to wire a motor to a battery.	1	**Big Ideas:** Current electricity requires a complete circuit, including an energy source and an energy receiver, in order to "work". Electricity can be dangerous. People are conductors and electricity will pass through a human body if it comes in contact with an electric current. We must practice safety behaviors indoors and outdoors to protect ourselves from an electric shock.	• Give students Part 1 of the Introductory Questionnaire (questions 1,2,3,5,9) before starting the unit. See Instructional Guide (IG) and p.24 of teacher's manual. • Have students draw sketches in science notebooks. Do not use black-line master from teacher's manual.	See *Extending Ideas* in the teacher's manual (p.63).
Learning Experience 1: What Do We Already Know? Students share what they know about electricity on a KWL chart.	1		Start collecting incandescent light bulbs for observations in Learning Experience 4.	
Learning Experience 3: Lighting the Bulb Students are challenged to light a bulb in different ways, using only a battery, a bulb, and wire.	1-2	**GLE 1.2.1:** Analyze how the parts of a system go together, and how these parts depend on each other. Identify the parts of a system and how the parts go together. **Big Idea:** Current electricity requires a complete circuit, including an energy source and an energy receiver, in order to "work."	Have students draw successful and unsuccessful configurations in science notebooks. Do not use black-line master from teacher's manual. See Instructional Guide.	Have students take a wire, D-cell, and bulb home to share their new knowledge with family members. See *Apply and Extend* in Instructional Guide.

[1] Pacing Guide for use with the *Circuits and Pathways* Teacher's Manual, Education Development Center, Inc. (1994)

Learning Experience 3.5: The Battery Students create a battery and discover how chemical energy is created through a chemical reaction.	1	**GLE 1.1.4:** Understand that energy comes in many forms. Describe the forms of energy present in a system. **GLE 1.2.2:** Understand that energy can be transferred from one object to another and can be transformed from one form of energy to another. **See Big Ideas for Learning Experience 2.**	• This lesson is not in the manual. See Instructional Guide for complete lesson plan. • Reading Integration: Students read "Alessandro Volta, The Battery Guy" in *Electric Circuits* (pp.13-16).	• See *Apply and Extend* in Instructional Guide for questions to guide further investigations. • Reading Integration: Students read articles on other inventors in *Electric Circuits* (Benjamin Franklin, Luigi Galvani, and Thomas Edison). See *Apply and Extend* in Instructional Guide.
Learning Experience 5: Conductors and Nonconductors Students apply their knowledge of simple circuits to determine which materials conduct or do not conduct electricity.	1	**GLE 1.1.1:** Understand how to use properties to sort natural and manufactured materials and objects. **Big Ideas:** Some materials allow current to flow easily (conductors); some do not (insulators). Conducting or insulating is a property of the material. Good conductors are metal. Electricity can be dangerous. People are conductors and electricity will pass through a human body if it comes in contact with an electric current. We must practice safety behaviors indoors and outdoors to protect ourselves from an electric shock.	• Do not use battery holders or bulb holders, as suggested in manual. Students will use the holders after Learning Experience 7. • Have students make a data table in science notebooks to record results. Do not use black-line master in manual.	• Reading Integration: Students read "Electricity: Good News, Bad News" in *Electric Circuits* (pp.29-30). • See *Home-School Work* and *Extending the Learning Experience* in the teacher's manual (p. 97).
Learning Experience 4: What's Inside the Bulb? Students observe the inner structure of the bulb and trace the pathway of the electric circuit.	1-2	**GLE 1.2.1:** Analyze how the parts of a system go together, and how these parts depend on each other. Identify the parts of a system (e.g., a device or living thing) and how the parts go together. **Big Ideas:** Current electricity requires a complete circuit, including an energy source and an energy receiver, in order to "work." An electric circuit is a system made up of parts that work together to perform a function. Electrical systems can do things that the parts cannot do alone. If a part of the system is missing or damaged, the system will work differently or not at all.	• See Instructional Guide for instructions on how to safely break open light bulbs. • Have students draw observations in science notebooks; do not use black-line master.	• Reading Integration: Students read "What's the Best Bulb?" in *Electric Circuits* (pp.36-38). • See *Home-School Work* and *Extending the Learning Experience* in the teacher's manual (p.86).
Classroom-Based Assessment A: Conductors and Nonconductors	1	**GLE 1.1.1:** Understand how to use properties to sort natural and manufactured materials and objects. **GLE 2.1.3:** Understand how to construct a reasonable explanation using evidence.		
Learning Experience 6: Predictions #1 Students apply their knowledge of complete circuits by analyzing drawings of circuits and predicting whether the bulb will light.	1	**GLE 1.1.4:** Understand that energy comes in many forms. Describe the forms of energy present in a system. **GLE 1.2.1:** Analyze how the parts of a system go together, and how these parts depend on each other. Identify the parts of a system (e.g., a device or living thing) and how the parts go together. **See Learning Experience 4 for Big Ideas.**		See *Home-School Work* in the teacher's manual (p.108).

Learning Experience 7: Predictions #2 Students apply their knowledge of complete circuits by drawing connecting wires onto drawings of batteries and bulbs.	1	**See Learning Experience 6 for GLE 1.1.4 and 1.2.1.** **GLE 1.2.2:** Understand that energy can be transferred from one object to another and can be transformed from one form of energy to another. **Big Ideas:** Current electricity requires a complete circuit, including an energy source and an energy receiver, in order to "work." An electric circuit is a system made up of parts that work together to perform a function. Electrical systems can do things that the parts cannot do alone. If a part of the system is missing or damaged, the system will work differently or not at all. Electricity can be dangerous. People are conductors and electricity will pass through a human body if it comes in contact with an electric current. We must practice safety behaviors indoors and outdoors to protect ourselves from an electric shock.		• Reading Integration: Students read "Where Does Electricity Come From?" (pp.24-27) and "Electricity: Good News, Bad News" (pp.29-30) in *Electric Circuits*. • A field trip to the Cedar River Watershed as well as classroom programs on electricity are offered by Seattle City Light; contact Education Coordinator Mark VanOss at mark.vanoss@seattle.gov or 206.684.3279
Classroom-Based Assessment B: Completing the Circuit	1	**GLE 1.2.1:** Analyze how the parts of a system go together, and how these parts depend on each other.		
Learning Experience 7.5 Lesson 1 – The Path of Light Students discuss what they think they know about light and use flashlights to explore the path that light travels.	1	**GLE 1.1.3:** Understand the behavior of light in terms of bouncing off, passing through, and changes in direction. Students will identify or describe the motion of light as light bounces off, and/or passes through an object. **GLE 1.1.4:** Understand that energy comes in many forms. Describe the forms of energy present in a system. **GLE 1.2.2:** Understand that energy can be transferred from one object to another and transformed from one form to another. Describe transfers of energy. Identify sources of energy in systems. Describe transformations of energy. **Big Idea:** Light travels in a straight line or path until it reaches an obstacle. We cannot see light between the source and the obstacle on which it is shined.	Learning Experience 7.5 (Lessons 1-4) is not in the teacher's manual. It has been added to provide students more in-depth experiences with light and to meet GLE 1.1.3. Complete lesson plans are provided in the Instructional Guide and materials are provided in the kit.	Reading integration: Students read "Stage Light, Stage Bright" in *Electric Circuits* (pp.39-41). This article can be read any time during Learning Experience 7.5.
Learning Experience 7.5 Lesson 2 – Light Reaching Obstacles (Part 1) Students explore how light behaves when shined on mirrors.	1	**GLE 1.1.3:** Understand the behavior of light in terms of bouncing off, passing through, and changes in direction. Students will identify or describe the motion of light as light bounces off, and/or passes through an object. **GLE 2.1.3:** Understand how to construct a reasonable explanation using evidence. Describe a reason for a given conclusion using evidence from an investigation. **GLE 2.1.5:** Understand how to report investigations and explanations of objects, events, systems, and processes. **Big Idea:** Light is reflected off some surfaces and absorbed by others.		

Learning Experience 7.5 Lesson 3 – Light Reaching Obstacles (Part 2) Students explore how light behaves when shined on different materials.	1	**See Learning Experience 7.5, Lesson 2 for GLEs.** **Big Idea:** When light reaches an obstacle, it will do one of four things: 1.All of light will pass through the obstacle, 2. Some of the light will pass through the obstacle, 3.All of the light will be absorbed by the obstacle, 4. All of the light will be reflected by the obstacle.	Collect three clear plastic bottles with lids for the recommended extension. You will also need to provide a few drops of milk.	See recommended *Apply and Extend* activity in the Instructional Guide.
Learning Experience 7.5 Lesson 4 – Summing Up Students review what they have learned about the behavior of light.	1	**See Learning Experience 7.5, Lessons 1-3 for GLEs and Big Ideas.**		Students can investigate unanswered questions about light. See Instructional Guide.
Learning Experience 14: Hidden Circuits Students use their knowledge of circuits to create hidden circuits for others and find hidden circuits.	2-3	**GLE 1.2.2:** Understand that energy can be transferred from one object to another and can be transformed from one form of energy to another. **GLE 3.1.3:** Analyze how well a design or product solves a problem. **Big Idea:** Current electricity requires a complete circuit, including an energy source and an energy receiver, in order to "work".	• Introduce the d-cell holders and bulb holders at this time. • Eight circuit folders come pre-made in the kit. You do not need to make them. • Have students record results in their science notebooks; do not use black-line master. See Instructional Guide.	Students can make circuit "Quiz Boards." See *Apply and Extend* in Instructional Guide.
Learning Experience 8: Series Circuits Students explore how to create series circuits and the impact of different configurations on bulb brightness.	2	**GLE 2.1.2:** Understand how to plan and conduct simple investigations following all safety rules. **Big Idea:** Series and parallel are kinds of circuits with different properties that can be identified through observation.	• Give students Part 2 of the Introductory Questionnaire (questions 4, 6, 7, 8, 10, 11, 12) before Learning Experience 8. See Instructional Guide and p.24 of the teacher's manual. • Prepare a wall chart of guiding questions in Instructional Guide. • Have students draw circuits in science notebooks; do not use black-line masters.	• See *Apply and Extend* in Instructional Guide. • Reading Integration: Students read articles from "Part 3: Electricity in Nature" in *Electric Circuits* at any time between Learning Experience 8 and the end of the unit. See p.46 for an overview of Part 3.
Learning Experience 9: Brightness Meters Students discuss the question of how to measure bulb brightness and construct a brightness meter.	1	**GLE 2.1.2:** Understand how to plan and conduct simple investigations following all safety rules. **Big Idea:** Series and parallel are kinds of circuits with different properties that can be identified through observation.	• Use Brightness Meter master in IG; do not cut strips of paper. • Discuss with students the variables affecting measuring brightness. This is critical for future lessons.	Students can measure brightness of bulbs at home. See *Home-School Work* in the teacher's manual (p.141).
Learning Experience 10: Parallel Circuits Students explore how to set up parallel circuits and the impact of different configurations on bulb brightness.	2	**GLE 2.1.2:** Understand how to plan and conduct simple investigations following all safety rules. **Big Idea:** Series and parallel are kinds of circuits with different properties that can be identified through observation.	• Use wall charts from Learning Experience 8. • Have students draw circuits in science notebooks; do not use black-line masters.	• Students can plan a new investigation exploring series and parallel circuits. See *Apply and Extend* in Instructional Guide. • See *Extending the Learning Experience* in the teacher's manual (p.157).

Classroom-Based Assessment C: Comparing Series and Parallel Circuits	1	**GLE 2.1.2:** Understand how to plan and conduct simple investigations following all safety rules. **GLE 2.1.3:** Understand how to construct a reasonable explanation using evidence.		
Learning Experience 11: Switches Students discuss switches and how they work, and are challenged to make a simple switch.	1	**GLE 2.1.2:** Understand how to plan and conduct simple investigations following all safety rules. **GLE 3.1.1:** Understand problems found in ordinary situations in which scientific design can be or has been used to design solutions. **GLE 3.1.3:** Analyze how well a design or product solves a problem [challenge]. **Big Idea:** Switches and fuses are components of circuits with specific functions.	• Cut one tag board piece for each student. • Preview and cue *Apollo 13* if you choose to use it as part of this lesson. See IG. • Have students draw switches in their science notebooks; do not use black-line master.	• See *Apply and Extend* in Instructional Guide. • See *Home-School Work* and *Extending the Learning Experience* in the teacher's manual (p.168).
Learning Experience 12: Resistance (includes 12A, 12B, 12C) Students plan and conduct three controlled investigations to determine the effect of wire material, length, and thickness on the brightness of a bulb in a simple circuit.	3-5	**GLE 2.1.1:** Understand how to ask a question about objects, organisms and events. **GLE 2.1.2:** Understand how to plan and conduct simple investigations following all safety rules. **GLE 2.1.3:** Understand how to construct a reasonable explanation using evidence. **GLE 2.1.5:** Understand how to report investigations and explanations of objects, events, systems, and processes. **GLE 2.2.3:** Understand why similar investigations may not produce similar results. **GLE 2.2.4:** Understand how to make the results of scientific investigations reliable. **Big Idea:** Electrical resistance is a property of materials. Several factors influence resistance including the length, width, and type of material.	• This lesson is completely modified from the lesson in the teacher's manual. It has been changed into three lessons to provide students experiences in planning and conducting controlled investigations. **See Instructional Guide for complete lesson plans and specific information on advance preparation of materials.** • Make wall charts of Planning Lists for Controlled Investigations. See IG. • Have students make data tables in science notebooks to record results.	Students can investigate the effect of curliness of wire on bulb brightness. See *Apply and Extend* of Learning Experience 12C in Instructional Guide.
Learning Experience 13: Fuses Students apply what they have learned about resistance by exploring and building fuses.	1	**GLE 2.1.2:** Understand how to plan and conduct simple investigations following all safety rules. **Big Idea:** Switches and fuses are components of circuits with specific functions.	• Use "best" batteries for this lesson, not "good" batteries. • Have students record answer to focus question in science notebook; do not use black-line master.	• See *Apply and Extend* in IG. • Reading Integration: Students read "Living with Electricity" (pp.32-33) and "Electricians Have a Hot Job" (pp.42-44) in *Electric Circuits*.
Classroom-Based Assessment D: Switches and Fuses	1	**GLE 1.2.1:** Analyze how the parts of a system go together, and how these parts depend on each other. **GLE 3.1.1:** Understand problems found in ordinary situations in which scientific design can be or has been used to design solutions.		

Learning Experience 15: Mystery Boxes (Embedded Assessment) Students construct mystery circuit boxes for other groups to solve.	2-3	**GLE 1.2.2:** Understand that energy can be transferred from one object to another and can be transformed from one form of energy to another. **Big Ideas:** Current electricity requires a complete circuit, including an energy source and an energy receiver, in order to "work".	• You must make a sample mystery box to demonstrate with students. See Instructional Guide and *Directions Sheet* in the teacher's manual. • Have students make data tables in their science notebooks; do not use black-line master.	
Classroom-Based Assessment E: Problem-solving strategy for Mystery Boxes	1	**GLE 1.2.1:** Analyze how the parts of a system go together, and how these parts depend on each other. **GLE 1.2.2:** Understand that energy can be transferred from one object to another and can be transformed from one form of energy to another.	Students may use their data tables from Learning Experience 15 to help them with this assessment.	