Teacher:

Subject area / course / grade level: ___ *grade Science – Electricity Unit*

Materials: Safety goggles, D-cell batteries, wires, flashlight bulbs, battery holders, bulb holders, switches, motors, circuit boards, science notebooks, and pencils

National Science Content Standards: Abilities necessary to do scientific inquiry. Understanding about scientific inquiry. Properties of objects and materials. Light, heat, electricity, and magnetism. Abilities of technological design. Understanding about science and technology. Science and technology in local challenges. Science as a human endeavor.

NC SCOS Competency Goal 3: The learner will make observations and conduct investigations to build an understanding of magnetism and electricity.

Lesson objective(s): 3.03 Design and test an electric circuit as a closed pathway including an energy source, energy conductor, and an energy receiver.
TLW Define D-cell battery, electricity source, electricity receiver, and components.
TLW Observe the functioning of different kinds of circuits.
TLW Identify the essential components of an electrical circuit and understand their functions.
TLW Draw a diagram to represent electric circuits.
TLW Construct a complete circuit when given an energy source, energy conductor, and an energy receiver.

Differentiation strategies to meet diverse learner needs:

- Flexible grouping
- Tiered assignments

ENGAGEMENT

Begin with a discussion about holiday decorations. What types of decorations do you see in stores and neighborhoods at this time of year? (Answers can include anything related to Christmas, Hanukkah, or Kwanzaa.) Someone should suggest Christmas lights. If this happens early in the discussion, continue to record responses for another minute or two and then return the class focus to the lights. Ask students if they have ever noticed a string of Christmas lights that had 1 or more bulbs burn out, but the others stayed lit? Have you ever seen a string of lights that wouldn't light at all? Did you wonder why that was? What makes the lights work? (they will probably say electricity) Give each student a sticky note. On your sticky note, write one thing you wonder about electricity and then take your note to our Wonder Wall and post it there. (These will become guiding questions for the teacher during exploration of the topic.)

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EXPLORATION

Introduce the simulation. The holidays are coming and I (the teacher) am the president of a company that makes Christmas Lights. The orders are really starting to back up so I have decided to hire each of you (students) to work in my factory. You'll need to start with some basic training and then move on from there. Eventually some of you may become supervisors, electricians, or mechanical and design engineers. We already know that electricity can cause a light bulb to light up, but how does it work? That is your first task as a trainee. I have given each of you a wire, a bulb, and a battery (Offer some words of caution at this point: a battery that is heating up rapidly means a short circuit and you should try something else; touching the bare wire can burn or shock you so please use caution; wear your safety goggles at all times; if a light bulb should break please raise your hand and let me know – do not try to clean it up yourself). Try to make your bulb light up. Draw pictures/diagrams in your "training manual" (notebook) to show what works and what doesn't work. Let me know when you have successfully made your light bulb light up and you will receive a promotion to trainee level 2.

Note: The teacher should stay in character as the President of the company as much as possible to encourage students to see this as a real world simulation.

EXPLANATION

As students complete the first task, ask them what shape was formed by their items when the bulb was lit. They should recognize it as a circle. Introduce the concept of a complete circuit as an unbroken circle that allows the electric current to travel from one item to the next. Students should stop and make a drawing in their " training manuals". As multiple students come to this conclusion, allow them to begin pairing up into training groups. Give each partnership a bulb holder, battery holder, and another wire. Challenge them to make a complete circuit causing the bulb to light while using all of these materials. Tell the trainees that they will be promoted to electrician 1 status when they can complete this task. Continue to make notes in your "training manual" about what works and what doesn't work. (Circulate amongst the groups as they work. Offer words of encouragement but no actual assistance. Some groups will accomplish the task but won't use the clips appropriately. Challenge them to build a complete circuit that functions even when they are not touching any part of it. Ask students to consider the role of each piece of equipment. Point to an item and ask them what it does/how is it useful in creating a complete circuit? As students discover the purpose of the battery (energy source), light bulb (energy receiver), wire (energy conductor), battery holder, bulb holder, and Fahnestock clips ask them what they think they are called have them write their own names for those items in their "training manuals".)

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ELABORATION

Once students have given their own explanations, drawn their own diagrams, and labeled the items with their own names it is time to offer training for students to become Level 1 Electricians. Introduce the idea of having common language and symbols in our business to enable everyone to create complete circuits in the same way. Explain that this will help us to increase production and sell more Christmas Lights that are reliable and make our customers happy. Tell students that from now on we will call these items battery holders, bulb holders, and Fahnestock clips which are named for the man who invented them. We can use energy source and battery, energy conductor and wire, and energy receiver and light bulb interchangeably from this point forward. Share the electrical symbols for a light bulb and battery (d-cell) and have students copy them into their training manuals. Demonstrate using the symbols to draw a simple series circuit. Have students copy this into their training manual and instruct them that as Electricians they will be expected to use these symbols to diagram their work from this point forward.

Student partnerships will continue to progress through the next levels at their own pace. The teacher maintains the role as president of the company throughout the remainder of the simulation offering words of commendation, calling "staff meetings" when whole group instruction/intervention is needed or as the class period draws to a close and the "work day" needs closure.

Continuation of the simulation:

At each promotion, students should be encouraged to name new equipment based on their own experiences before the teacher gives them the actual name. It may be necessary to give some hints.

The following progression should be followed to complete the simulation:

- Electrician 1 – receives a circuit board in addition to all previous equipment
- Electrician 2 – receives a switch in addition to all previous equipment (upon circuit completion these students receive training in drawing the symbol for a switch)
- Mechanical Engineer 1 – This level of worker has full rights to the storage facility and may get any materials they believe are important to completing their task. It is their job to create a string of 2 lights that can be turned on and off by the switch. (series circuit)
- Mechanical Engineer 2 – This worker must create a string of lights that allows one bulb to be off while the other one stays on. (parallel circuit)
- Mechanical Engineer 3 – This worker must create a variety of complete circuits by following given electrical diagrams.

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EVALUATION

If a few students are excelling while others are struggling, call a staff meeting and promote those students to supervisor. Allow them to move from group to group offering words of advice with the limitation that they not touch any of the equipment in the other groups. As groups begin to catch up, return the supervisors to their department.

Another option would be to move a slow moving group of students into the "Research and Development" department. These students would then visit other groups who have been more successful looking for ideas and asking questions. After a few minutes, announce that funding for Research and Development has run out and they will have to return to their work stations.

In order to be promoted through the simulation, students must demonstrate that they have achieved the objective for the current task. Students who successfully complete the Mechanical Engineer 3 tasks will have the option of doing their own Research and Development with a mystery item (a motor) or acting as a supervisor.

Evaluation Tools:

- Teacher observation and anecdotal records.
- Performance Tasks Rubric (see attached)
- Student Notebook/Training Manual
- Writing Probe Final Evaluation – "Explain why some strings of Christmas lights will stay lit when one bulb burns out and other strings of lights will not."

EXTENSIONS

- Make a list of items that use electricity.
- Make a list of items that use a motor.
- Design and build a hidden circuit file folder matching game.
- Draw an electrical schematic diagram and give it to your partner to build

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Rubric: Fantastic Fourth Grade Electric Company

This is a hands-on/minds-on inquiry based simulation in which students design and test an electric circuit as a closed pathway including an energy source, energy conductor, and an energy receiver.

Fantastic Fourth Grade Electric Company Levels of Achievement are designed to match the level of education required to attain a career in that field.			
	Electronics Technician	**Electrician**	**Electronics Drafter**
	1 pt. – Requires at least a high school diploma.	2 pts. – Typically requires a minimum 4 year apprenticeship.	3 pts. – Requires a minimum of 2 years post-secondary education.
Training Manual Assesses your ability to maintain accurate records in your notebook.	Contains detailed diagrams and training notes for 1-2 accomplished tasks.	Contains detailed diagrams and training notes for 3-5 accomplished tasks.	Contains detailed diagrams and notes for every accomplished task.
Problem-Solving Assesses your ability to be persistent, ask good questions, and try many different strategies to accomplish your task.	Employs 1 or 2 strategies to accomplish each task. Requires frequent encouragement by a "supervisor" and arrives at a solution for each task with a great deal of extra support.	Employs 2-3 strategies to accomplish each task, is easily encouraged by a "supervisor" and arrives at a solution for each task with minimal extra support.	Employs multiple strategies to accomplish each task, is persistent, asks questions and requests additional materials as needed. Acts as a supervisor to other groups of students as needed.
Team Work Assesses your ability to cooperate with your partner, share materials, encourage others, and be responsible.	Shares responsibility and takes turns throughout some of the simulation.	Values the ideas of your partner. Shares responsibility and takes turns throughout most of the simulation.	Values the ideas of your partner. Cooperates well and encourages other groups to keep trying until they succeed. Shares responsibility and takes turns throughout the entire simulation.
Technical Vocabulary Assesses your ability to implement new vocabulary into your discussions, problem-solving, and notebook.	Makes very little use of the new vocabulary as it is introduced and during subsequent tasks throughout the simulation.	Makes use of some of the new vocabulary as it is introduced and during subsequent tasks throughout the simulation.	Makes use of all new vocabulary as it is introduced and continues to use these words appropriately in subsequent tasks throughout the simulation.
Teacher comments:		Final Grade:	

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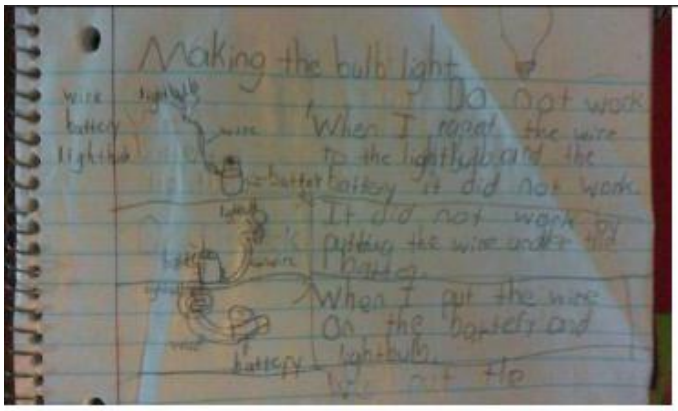

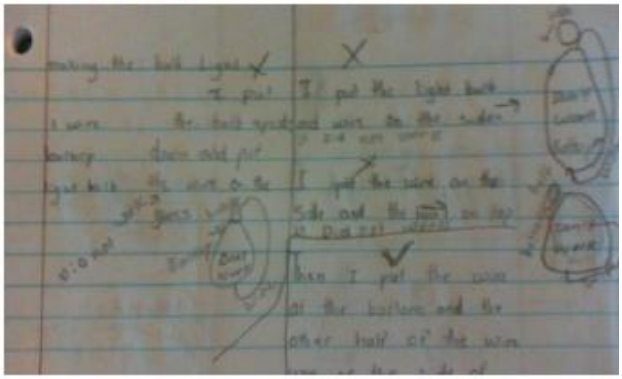

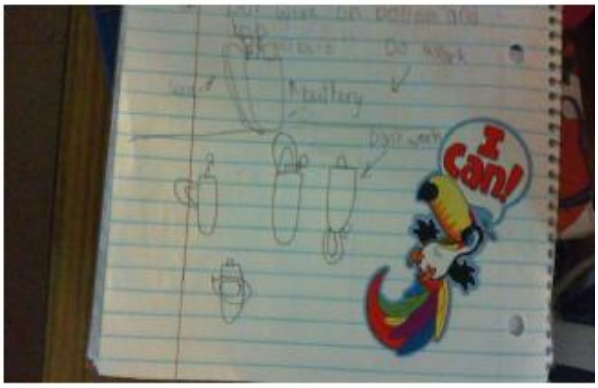

Senior Engineer offers training advice to an Electrical Technician

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