Electrical Engineering

Students are presented with the problem of modeling a circuit that connects four neighborhoods to a city's power plant. They must determine which of two circuits would cause the least number of neighborhoods to be without power if a break occurred in a power line. To solve this problem, students will apply the concepts they have learned about electric current and series and parallel circuits.

◆ Expected Outcome

Students will work in pairs to make a circuit using insulated wires, a battery, and 4 small light bulbs. Half of the class will make and test a parallel circuit (circuit A), and the other half of the class will make and test a circuit that is a combination of series and parallel (circuit B). Students will number the wires in their circuits using the diagrams on the student page. To model a break in the circuit, they will disconnect wire 1 and record the number of bulbs that do not light. After replacing wire 1, they will disconnect wire 2, count the number of bulbs that do not light, and so on until they have gathered data for each wire in the circuit. Then students will use these data to calculate the average number of bulbs that go out when a wire is disconnected from the circuit. See the answer key for sample data tables. Students who tested circuit A will compare their averages to those calculated by students who tested circuit B. Students should find that an average of 1.9 bulbs go out when a wire is disconnected from circuit A and that an average of 2.5 bulbs go out when a wire is disconnected from circuit B. They should conclude that, on average, a parallel circuit would cause the least number of people to be without power if a break occurred in the circuit.

◆ Content Assessed

The Performance Assessment tests students' understanding of electric current and series and parallel circuits.

◆ Skills Assessed

making a model, creating a data table, drawing conclusions, applying concepts

◆ Materials

- Provide each pair of students with 4 small light bulbs, 4 light bulb sockets, and insulated wire.
- Pairs will also need either a D cell or a 6-V battery, depending on the type of light bulbs used. Build the two circuits ahead of time to determine which voltage works better.

◆ Advance Preparation

Cut the wire into about 20-cm lengths. Each pair of students will need either 8 or 14 pieces of wire depending on the circuit they build. Strip the insulation from the ends of the wires with wire strippers.

◆ Time

50 minutes

◆ Safety

Remind students not to leave the battery connected to the circuit longer than a few seconds to avoid overheating.

◆ Monitoring the Task

- To make sure students understand what will be expected of them, ask volunteers to explain in their own words what they will be doing in this activity. Allow students to ask any initial questions they might have.
- Assign half of the class to build circuit A and half to build circuit B. Students testing circuit B will most likely finish sooner because they will have fewer wires to test. As a result, you may want to have this group build and test a second circuit with the four bulbs arranged in series.

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In assessing students' performance, use the following rubric.

	4	3	2	1
Building and Testing the Circuit	Student accurately builds the assigned circuit. Data table is complete and accurate. Student correctly calculates the average number of bulbs that go out when a break occurs in the circuit. Student concludes that circuit A is a better design than circuit B. Student's conclusions are based on gathered data.	Student makes a minor error in building the assigned circuit. Data table is complete, but one or two entries are inaccurate. Student makes a minor error in calculating the average number of bulbs that go out when a break occurs in the circuit. Student concludes that circuit A is a better design than circuit B. Student's conclusions are based on gathered data.	Student makes one or two minor errors in building the assigned circuit. Several pieces of data are missing from the table or are inaccurate. Student makes a minor error in calculating the average number of bulbs that go out when a break occurs in the circuit. Student concludes that circuit A is a better design than circuit B. However, student's conclusions are only partially based on gathered data.	Student makes some major errors in building the assigned circuit. Many pieces of data are missing from the table or are inaccurate. Student makes a major error in calculating the average number of bulbs that go out when a break occurs in the circuit. Student fails to conclude that circuit A is a better design than circuit B. Student's conclusions are not based on gathered data.
Concept Understanding	Student demonstrates a mastery of concepts related to electric current and series and parallel circuits.	Student demonstrates a good understanding of concepts related to electric current and series and parallel circuits.	Student demonstrates a partial understanding of concepts related to electric current and series and parallel circuits.	Student demonstrates a minimal understanding of concepts related to electric current and series and parallel circuits.

Name _____ Date _____ Class _____

PERFORMANCE ASSESSMENT

Electrical Engineering

◆ Problem

Design a circuit that will connect four neighborhoods to a city's power plant. Design the circuit so that if a break occurs in one of the lines, the least number of neighborhoods will be without power.

◆ Suggested Materials

4 small light bulbs and sockets battery insulated wire

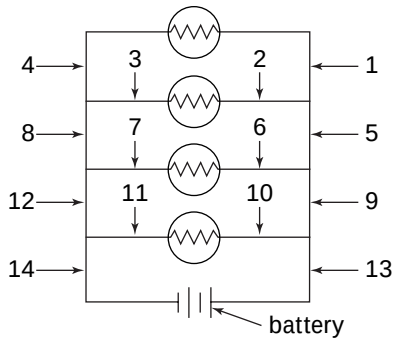
◆ Devise a Plan

1. Work with a partner to study the materials and determine how they could be used to build one of the circuits shown below.

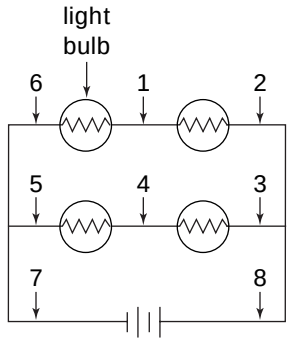
2. On a separate sheet, make a data table to keep track of the number of unlit bulbs for each disconnected wire. Include a row for each wire of your circuit.

3. Set up and test your circuit. All four bulbs should light up. Then disconnect the battery.

4. Disconnect one wire at a time from your circuit. Reconnect the battery each time, and count the number of bulbs that do not light. Record this number in your data table. Repeat this step for each wire in your circuit. Then, calculate the average number of bulbs that go out when a wire is disconnected.



Circuit A



Circuit B

◆ Analyze and Conclude

After following the plan you devised, answer the following questions.

1. Which part of your model represented the electric power plant? The four neighborhoods? The power lines? How did you model a break in a power line?

2. The average you calculated above represents the average number of neighborhoods that would be without power if a break occurred in one of the lines. Compare the average for your circuit with the average calculated by another pair of students for the other circuit. Which circuit would be a better design for connecting the neighborhoods? Is each circuit arranged in series, parallel, or a combination?