

Electrical Engineering Challenge

Strand	Force, Motion, and Energy
Topic	Investigating circuits
Primary SOL	4.3 The student will investigate and understand the characteristics of electricity. Key concepts include b) basic circuits.
Related SOL	4.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which b) objects or events are classified and arranged according to characteristics or properties; e) predictions and inferences are made, and conclusions are drawn based on data from a variety of sources; l) models are constructed to clarify explanations, demonstrate relationships, and solve needs. 4.3 The student will investigate and understand the characteristics of electricity. Key concepts include a) conductors and insulators.

Background Information

One can create several basic circuits using an energy source, wires, and a load. A battery (e.g., a dry cell) can be a source supplying electric energy for these types of circuits. The load (the object that uses the energy) is a light bulb in this lesson.

The four basic types of circuits in this lesson are as follows:

Open circuit - An open circuit is a circuit that has a gap or a break. This type of circuit will not allow electricity to flow.

Closed circuit - Closed circuits are free of gaps and breaks. This circuit has at least one complete path to and from the source allowing electricity to flow.

Series circuit - A series circuit has more than one load all along the same path to and from the source.

Parallel circuit - A parallel circuit is a circuit with more than one path to and from the source.

Materials

- Copies of the attached Electrical Engineer Challenge packet for each student
- Copies of the Challenge Journal made into book format for each student
- Short book or video about Thomas Edison

For each small group, a box that includes:

- Five wires (at least 10 cm in length)
- Two bulb holders
- Two minibulbs
- One D-battery

- Aluminum foil
- Pencil
- Chalk
- Plastic toy
- Rubber eraser
- Switch
- Penny
- Reference sources, such as encyclopedias, trade books, or Internet sites

Vocabulary

circuit, closed circuit, open circuit, series circuit, parallel circuit, insulator, conductor, dry cell, switch, electric current

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Read a short book or watch a short video about Thomas Edison.
2. Discuss the processes that Edison went through in his lab and his effort and love for science. Be sure to mention that he was able to create a circuit through his experimentation.
3. Tell the students that they will pretend to be just like Thomas Edison as part of an Electrical Engineering Team and will be creating different circuits.

Procedure

1. Place students into groups of three to four students.
2. Give each group the box of materials and each student the attached Electrical Engineer Challenge packet and the Challenge Journal.
3. Have students review the packet.
4. Answer any questions that may arise.
5. Allow students to complete all of the challenges on their own with assistance given as needed.

Conclusion

1. As the groups finish their experiments, remind each student to complete their Challenge Journal.
2. When all students have completed their journal, have them pick a partner from another experiment group and share their results.

Assessment

- **Questions**
 - What are some similarities and differences between series and parallel circuits?
 - What are some similarities and differences between closed and open circuits?
 - Ask students to identify circuits that you make for them to view.
- **Journal/writing prompts**
 - Which type of circuit would best work in your house: series or parallel? Explain.

- All electricity ceases to exist today. How would your school change? Your house? Your city? Explain and be sure to give specific examples.
- **Other**
 - Have students draw diagrams of the four circuits explained in the activity. Under each circuit, have them explain their diagram.
 - Have students create a PowerPoint presentation explaining conductors, insulators, and the four circuit types using digital pictures of challenges they completed.

Extensions and Connections (for all students)

- Have students discuss connections between Edison’s lab and the classroom today.
- Have students try to make a circuit with one wire, one dry cell, and one bulb.
- Have students try to make a series circuit within a parallel circuit using three bulbs.

Strategies for Differentiation

- Reference materials can be leveled appropriately for the group. If groups are heterogeneously grouped, then several levels should be available to the groups.
- If available, a pretest can group students into leveled groups. The teacher then can provide more consistent support to groups scoring lower on the pretest. Because there are several different ways to make a series and parallel circuit, challenge higher scoring groups to create more than one form of the same circuit.
- Invite an electrician or a high school physics student to visit the classroom.
- Create Venn diagrams to compare the similarities and differences between open and closed circuits; parallel and series circuits.

Electrical Engineering Challenge

Congratulations, you are a member of an elite electrical engineering team! Below, your lead engineer has several challenges for your team. Do your best to work together and find your answers. After you finish each challenge, have each of your teammates quietly raise their hands to get the lead engineer's attention. Once she or he has asked you a few tough questions about your completed work, you may go to your next challenge.

Challenge 1

Your challenge is to make a bulb light and to record your results. With **one bulb, one bulb holder, one dry cell, and two wires** try to make the bulb light.

1. In your Challenge Journal, draw a picture of a way you tried that did not work.
2. Use your materials to research and find the name of this circuit.
3. In your Challenge Journal, draw a picture of your circuit with the bulb lit.
4. Use your materials to research and find the name of this circuit.

Challenge 2

In challenge two, you will test several different materials. As engineers, you need to prove whether or not certain materials will allow electrical current to flow. Design an experiment to test each of the following materials:

- o Rubber eraser
 - o Wooden toothpick
 - o Aluminum foil
 - o Paperclip
 - o Plastic toy
 - o Chalk
 - o Pencil
 - o Penny
1. Explain in complete sentences how you designed your experiment. Draw a sketch to support your answer.
 2. Use your research materials to find the names of the following:
 - a. Materials that allow electricity to flow.
 - b. Materials that do not allow electricity to flow.
 3. Look closely at your findings and you might be able to discover a pattern. Write a conclusion based on your findings. Be sure to use what you found in your experiment in your answer.

Challenge 3

Challenge three is a bit more difficult. If you try hard to use what you learned from challenge one, I know you can do it. With **two bulbs, two bulb holders, one dry cell, and three wires** try to make both bulbs light.

1. In your Challenge Journal, draw a picture of your circuit with both bulbs lit.
2. Use your materials to research and find the name of this circuit. (Hint: Count how many paths there are to the battery.)
 - The single bulb in challenge one was brighter than challenge three bulbs.
 - The single bulb in challenge one was dimmer than challenge three bulbs.
 - The single bulb in challenge one was the same brightness as the challenge three bulbs.
3. Using your research materials, do your best to explain your answer for the last question.
4. While both bulbs are lit, take one out. What happens to the bulb left in? Why?

Challenge 4

I am impressed you have made it this far! This challenge may be your most difficult one yet. With **two bulbs, two bulb holders, one dry cell, and four wires** try to make both bulbs light. In this challenge *create one path* from and to the battery *for each bulb*.

1. In your Challenge Journal, draw a picture of your circuit with both bulbs lit each in a separate path.
2. Use your materials to research and find the name of this circuit.
3. Compare the brightness of the bulbs in challenge three and challenge four. Place a check next to the answer that best describes the comparison.
 - The bulbs in challenge three were brighter than challenge four bulbs.
 - The bulbs in challenge three were dimmer than challenge four bulbs.
 - The bulbs in challenge three were the same brightness as the challenge four bulbs.
4. Using your research materials, do your best to explain your answer for the last question.
5. While both bulbs are lit, take one out. What happens to the bulb left in? Why?

Challenge 5

Now it is time to explore the switch. With your materials, explore the use of a switch.

1. In your Challenge Journal, draw a picture of your favorite use of the switch.
2. Conclusion: After exploring the use of a switch, what are some ways this could be used in your house? There are many answers for this question. Try to choose one that you don't think anyone else will.

Challenge Journal

Names: _____ Date: _____

Challenge One

1. Draw one way that didn't work.

2. Use your materials to research and find the name of the circuit above.

3. Draw a way that worked.

4. Use your materials to research and find the name of the circuit above.

Challenge Two

1. Explain how you designed your experiment.

- Now sketch your experiment.

2. Place a check on only the items you found that allowed electrical current to flow.
 - Rubber eraser
 - Wooden toothpick
 - Aluminum foil
 - Paperclip
 - Plastic toy
 - Chalk
 - Pencil
 - Penny
3. Conclusion:

Challenge Three

1. Draw a picture of your circuit with both bulbs lit.

2. Use your materials to research and find the name of the circuit above.

3. Check the best answer.
 - o The single bulb in challenge one was brighter than challenge three bulbs.
 - o The single bulb in challenge one was dimmer than challenge three bulbs.
 - o The single bulb in challenge one was the same brightness as the challenge three bulbs.

4. Explain the answer above.

5.

Challenge Four

1. Draw a picture of your circuit with both bulbs lit each in a separate path.

2. Use your materials to research and find the name of the circuit above.

3. Check the best answer.
 - o The bulbs in challenge three were brighter than challenge four bulbs.
 - o The bulbs in challenge three were dimmer than challenge four bulbs.
 - o The bulbs in challenge three were the same brightness as the challenge four bulbs.

4. Explain the answer above.

5.

Challenge Five

Draw one use of a switch.

What are some ways to use a switch?