Electrifying Electricity

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1. Overview

This lesson covers some of the basics of the flow of electricity and circuit design. The lesson is intended to be an introductory lesson to begin to understand the complexities of electricity, and further extension on the activity can included the mathematical theories of electricity, Ohm's and Kirchhoff's Laws. Furthermore, this lesson was structured such that students with little to no prior content knowledge would be able to complete the activity.

2. Purpose

The purpose of this lesson was to use common everyday items (batteries, wires, light bulbs) to explore the basics of electricity. The use of these common items can encourage student exploration and aid students in learning the theories of electricity. In addition students can begin to understand how common items in their world (their home, light switches, etc) can be wired efficiently and effectively.

3. Objectives

The objectives for this project were to:

- familiarize students with the components of electricity and circuits.
- provide students a hand-on experience to work on circuits and circuit design.
- explore the differences between series and parallel circuitry.
- demonstrate how parallel and series circuits can be used in electronics and electrical devices.
- interpret and discuss results.

4. Indiana Eighth Grade Standards Met

4.1. Science

4.1.1. Standard 1 – The Scientific View of the World

8.1.1 Recognize that and describe how scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory* leads to looking at old observations in a new way.

8.1.3 Recognize and describe that if more than one variable changes at the same time in an experiment, the outcome of the experiment may not be attributable to any one of the variables.

8.1.4 Explain why accurate record keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society.

4.1.2. Standard 2 – Scientific Thinking

8.2.3 Use proportional reasoning to solve problems.

8.2.6 Write clear, step-by-step instructions (procedural summaries) for conducting investigations, operating something, or following a procedure.

8.2.7 Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.

8.2.8 Use tables, charts, and graphs in making arguments and claims in, for example, oral and written presentations about lab or fieldwork.

4.1.3. Standard 5 – The Mathematical World

8.5.3 Demonstrate that mathematical statements can be used to describe how one quantity changes when another changes.

4.2. English/Language Arts

4.2.1. Standard 4 – Writing: Processes and Features

8.4.2 Create compositions that have a clear message, a coherent thesis (a statement of position on the topic), and end with a clear and well-supported conclusion.

8.4.5 Achieve an effective balance between researched information and original ideas.

4.2.2. Standard 5 – Writing: Applications

8.5.2 Write responses to literature that:

- demonstrate careful reading and insight into interpretations.
- connect response to the writer's techniques and to specific textual references.
- make supported inferences about the effects of a literary work on its audience.
- support statements with evidence from the text.

8.5.6 Write using precise word choices to make writing interesting and exact.

4.2.3. Standard 6 – Writing: English Language Conventions

8.6.5 Use correct punctuation.

8.6.6 Use correct capitalization.

8.6.7 Use correct spelling conventions.

5. Methods and Timeline

5.1. Materials & Resources

- Parallel / Series boards
- Light bulbs (enough for 3-5 bulbs per each board)
- 5 V Light bulbs
- 12 V for each parallel / series board
- 1.5 V batteries for each 5V bulb
- Wiring for each of the 1.5 batteries

5.2. Procedures

5.2.1. Preparation

Although extensive knowledge of electricity and circuit design is not required for this activity, the students should have a basic understanding that there are two different circuit types: parallel and series.

5.2.2. Introduction to the Activity

Approximate Time: 15 minutes, depending on pre-existing knowledge. This activity is intended to be an introductory activity into circuits, and as such, little introduction is needed. In order to convey the practical nature of this activity, it should be emphasized electricity can be dangerous and that energy can take on many different forms (electricity and heat in particular in this activity). Students should be required to read the opening of the activity, which should explain a majority of the work they will be doing. The class can be separated into two groups, a battery light bulb group and series/parallel circuit group. After approximately 15 minutes, they will switch groups, and all work is intended to be individual work to allow for student exploration.

5.2.3. Flashlight and Series/Parallel Circuits

Approximate Time: 0.5 – 1 (30 - 50 minutes). Students should work alone if possible to encourage self-exploration of parallel and series circuits as well as how electricity flows. Students should also be encouraged to make mistakes when designing the parallel and series circuits, stating that many times the designs to not work right the first time. They should keep trying and work through how the electricity is flowing through the circuit.

5.2.4. Discussion and Final Thoughts

Some points for a wrap-up discussion include:

- Understand what is needed for an electrical circuit
- Describe some of the mathematical considerations for the circuits
- Determine why parallel circuits burn brighter than series

- Importance of the different circuits, pros and cons of each

6. Scope

For most Science classes the completion of the lesson should take no longer than two full class periods (~100 minutes). Additional discussion or introductory material could extend this to three periods. As a extension of the activity, the teacher can explain the mathematics behind the activity, detailing Ohm's Law and Kirchhoff's Laws.

7. Activities, worksheets, and templates

The worksheets used in this lesson are attached at the end of this document.

8. Evaluation

This lesson did not utilize pre- and post-testing as students should already have the necessary background and skills to complete this lesson. Further, the goal of the lesson was explore the differences between the circuit designs as well as to understand the basics of electricity. Evaluation in this lesson was based on the worksheet completed by each student and the in-class discussion.

9. Reflection/Lessons Learned/Alterations for future use

- Students seemed to be hesitant at first to try their designs for the parallel and series circuits, so explaining that they just need to start testing to see what happens can be effective.
- Although students knew that parallel circuits had multiple paths to ground and series circuits only had one, they were not very adept at visualizing this on the circuit board. However, having the students point out how the electricity was actually flowing the light bulbs seemed to help.
- In the flashlight activity, many students thought their flashlight or battery was dead. This is not the problem in general. But, one hint that can be given to students is to think about the number of terminals on a battery, and then apply that to the number of terminals on the light bulb. This can help students see how electricity can flow through the circuit.

10. Appendix

10.1. Electrifying Electricity Worksheet

Electrifying Electricity

Series / Parallel Circuits

There are two types of circuit designs you will need to build, a series and a parallel circuits. First read about each design, and then answer the first four questions. After answering the questions, construct the designs and then answer the follow-up questions.

Series Circuit:
In a series circuit, electricity has only one path on which to travel. Electricity flows from the voltage source to each bulb, one at a time, in the order they are wired to the circuit. In this case, electricity can only flow in one path, and the electricity flow is dependent on the other bulbs in the circuit. For example, if one of the bulbs blew out, the other bulb would not be able to light up because the flow of electric current would have been interrupted.

Parallel Circuit:
In a parallel circuit, electricity has more than one path on which to travel. Electricity flows in multiple paths allowing for each bulb to light independent from one anther. In this case, as the electricity can flow in more than one path, if one of the bulbs blew out, the other bulb would still be able to light up because the flow of electricity to the broken bulb would not stop the flow of electricity to the good bulbs.

Predictions and Pre-construction questions:
1. Do you think the bulbs in the parallel circuit or the series circuit will burn brighter? Explain in two-three sentences.

2. If you remove a bulb in your parallel circuit, with the other bulb(s) still light? Explain in two-three sentences.

3. If you remove a bulb in your series circuit, with the other bulb(s) still light? Explain in two-three sentences.

Draw a diagram of the series and parallel circuit designed.

Test and Results
After building the series and parallel circuits, now test your predictions for questions 2, 3 and 4 above, and respond to the questions.

1. Were your predictions about the brightness of the bulbs accurate? If not, what happened that was different than expected? Explain in detail.

2. Were your predications about what happened if a bulb was removed from the parallel and series circuits accurate? If not, what happened was different than expected? Explain in detail.

Discussion Questions
1. Do you think holiday lights are an example of parallel or series bulbs in a circuit? Explain in detail why you believe the holiday lights are either parallel or series.

2. When wiring a home, is it better to use a parallel circuit or series circuit. Use logical reasoning to discuss your answer.

Flashlight Design

In this project your goal is to build a flashlight using only one wire, one battery and one bulb.

Simple Circuits:
A simple circuit consists of three minimum elements that are required to complete a functioning electric circuit: a source of electricity (battery or power source), a path or conductor on which electricity flows (wire) and an electrical resistor (bulb, resistor, or other electrical element that requires electricity to operate). The flow of electricity is from source through the wire to the electrical element and back to the other terminal of the source, in a continuous flow. If one of these elements is missing, electricity will now flow.

Draw your prediction of how you are going to make your flashlight. Draw a minimum of three diagrams of how to light your flashlight.

Now construct your flashlight using your predicted diagrams as well as any others you decide to try.

Results
There are four different diagrams/schematics that can light your flashlight. Draw all four.

Discussion Questions
After building the flashlight, respond to these questions.

1. Did your initial flashlight designs actually light the flashlight? If not, what was different than expected? Explain in two-three sentences.

2. Explain, in your own words using two-three sentences, what electricity needs to flow and how to construct a simple circuit.

3. What are common sources of error in constructing a simple circuit, base your answer on your own experience building the flashlight.