Electricity, Circuits, and Magnetism OH MY!

Overview

In this lesson, students are introduced to electricity and simple circuits. They will learn the definition of electricity and terms we use to describe the flow of electricity such as: voltage, current, and resistance. Students will learn about circuits in series and in parallel. Using the described equipment they will construct their own circuits. Finally, students will learn how simple electromagnetic motors work and be able to make their own simple motor. This activity is appropriate for grades 6^{th}-9^{th}.

Objectives

Students should be able to:

- identify circuits in parallel and series
- define voltage as the amount of electricity going through a circuit
- define current as the amount of rate electricity flows through a circuit
- define resistance as the difficulty current has in flowing through a certain path
- describe how electro-magnetic motors work
- construct a circuit in series
- construct a circuit in parallel
- find voltage, current, or resistance if one of them is unknown using Ohm's triangle

Oregon State Science Standards 2009

Interaction and Change

6.2P.2 Describe the relationships between: electricity and magnetism, static and current electricity, and series and parallel electrical circuits.

Engineering Design

6.4D.2 Design, construct, and test a possible solution to a defined problem using appropriate tools and materials. Evaluate proposed engineering design solutions to the defined problem.

6.4D.3 Describe examples of how engineers have created inventions that address human needs and aspirations.

Student Pre-requisite Knowledge

Students should be familiar with parts of an atom, particularly the electron. Students should also be able to conduct simple multiplication and division in order to solve for Ohm's law.

Materials

Each group requires:

- 1, 9-volt batteries
- 2 light bulbs
- 1 circuit kit including:
  - 1 battery connector
  - 10 alligator clips
  - 3 knife switches
  - 2 light bulb holders
- 1 motor assembly
- 1 copper wire coil
- 1 magnetic wand

Teacher Preparation

Make sure to read through the power point and be able to construct the two main simple circuits. You should be able to define electricity. There is a You Tube video that shows the two different circuit configurations. (http://www.youtube.com/watch?v=ReuALEZQmD0, http://www.youtube.com/watch?v=BwUG4HTCaJQ)

Simple motor- Understanding the basics of Faraday's law will help you briefly describe how a current is induced in the electric coil of the simple motors. We have a You Tube video that will help you see how to do the simple motor set up. (http://www.youtube.com/watch?v=MnseGmX8rbY)

Procedure

1**. Anticipatory Activity-** There are several ways to introduce the idea of circuits.
A possible warm-up question is: What happens when a bulb on a string of Christmas lights goes out? This question may accompany a demonstration of removing a bulb from a plugged in strand. Give students a chance to brainstorm about what is happening and how the multiple bulbs in a strand of lights are connected. Continue by telling students that after today's activity they should be able to answer this question with authority.

2. Begin activity with Circuits 101 presentation provided. Refer to notes on each slide for key ideas and talking points.

3. At the end of the introduction presentation, instruct students to assemble their own circuits with the kits provided. Depending on class size, groups of 2-3 are common, though individuals are encouraged to work independently if supplies permit. Pass out a circuit kit. The 2 light bulbs and 9-volt battery are stored in separate containers for safety.

4. Demonstrate the common uses of the components in each kit. The light bulb holder and knife switch each have screws where students can attach alligator clips. The battery connector attaches to the battery and alligator clips are connected to the ends of each lead. **SAFTEY NOTE: the open ends of the battery connector should not touch each other and the circuit should not be completed without putting a light bulb in it.** This will cause the battery to short itself out.

5. SERIES: The first circuit the students should build is a simple series circuit that includes a battery, knife switch, and two light bulbs all connected in a loop with any combination of wires provided. (See figure 1 below.) The key idea here is that two light bulbs are dimmer than one light bulb because the voltage is shared among each bulb. Also, suggest to students to remove one of the light bulbs to see the effect, namely that if one bulb goes out, so does the other.

6. Next, have students build the parallel circuit with the two light bulbs and the knife switch. This circuit is a little more challenging but the key is to get students to connect each bulb to the battery at the same place so two of the connections in the circuit have more than one wire. (See figure 2 below.) The knife switch can be included in one loop or the other so that only one of the bulbs turns off and on or if the switch is the point of common connection, it will affect both bulbs. Again, have students remove one of the bulbs to see the effect; this time, the other bulb is still lit, demonstrating that each bulb is connected to the voltage source. Also, note the brightness of the bulbs compared to the series circuit.

7. After students have completed both circuits, issue them a challenge to make a circuit and include both lights and all three light switches. The goal is to make a circuit where there is a master switch (turns off both lights) and the other two switches turn off a light individually. The key here is to construct a circuit that has the bulbs wired in parallel but with a switch on each individual bulb circuit. See diagram below.

8. Once students have mastered the circuit configurations, demonstrate the simple motor: assemble the coil so that it rests between the two sheets of hardware cloth; attach the assembly to a battery using a set of alligator clips; place one magnet wand underneath the coil on the block of wood; give the coil a little spin to get it going and it should begin to spin on its own (can also use a second magnet wand by holding it above the coil). There is a specific spot where the magnet will allow the coil to spin freely. It takes some time to find the spot. The spinning occurs as the magnets attract and repel the copper coil, which has been magnetized by the current from the battery. Each group should try the activity with their own set of materials.

9**. Clean up**. When the activity is done, make sure each group properly returns all parts to the bag, except for the light bulbs and the batteries which are stored separately.

10. **Closure.** Review with students the differences between parallel and series circuits. Relate the concepts back to the wiring of their homes and Christmas lights. Review how a simple motor works.

Diagram of a circuit in parallel from web source, http://paphysicalscience.wikispaces.com/Electricity

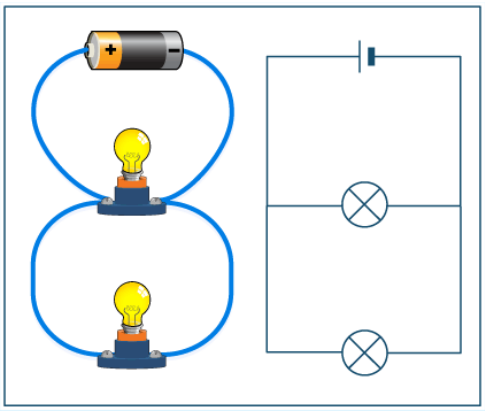


Diagram of a circuit in series from web source, http://paphysicalscience.wikispaces.com/Electricity

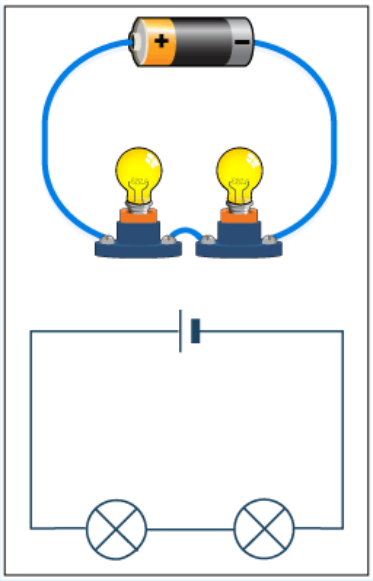
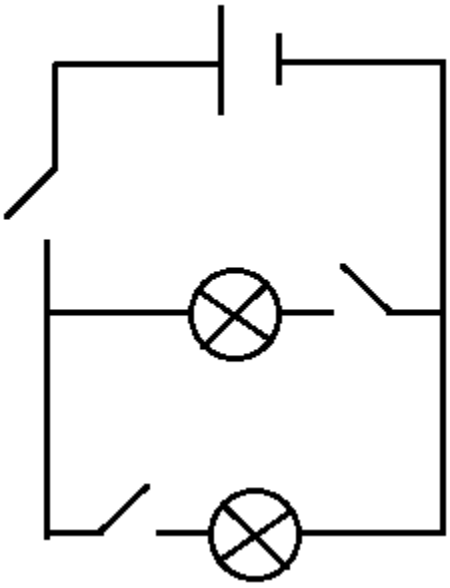


Diagram of the “challenge” circuit (this is one of many possible ways): COSEY diagram



EXTENSIONS

Teachers may design different circuits and present students with the task to recreate the circuit. A possible example may be designing a circuit where an open switch causes the lights to turn on. Challenge them with more complex circuits if extra materials are available. A good example challenge would be to have them make a circuit where an open switch turns the light on. Another possibility would be to have the students make a similar circuit to the challenge circuit but instead, open switches would turn the lights one.