

Lesson Plan

Assessment	AFL, AOL
Cross-curricular	

Big Ideas

- Relationships between electricity and magnetism are predictable.
- Electricity and magnetism have many technological applications.

Learning Goals

- I know the terms conventional current, electron flow, electrical potential difference, and series circuit and parallel circuit.
- I can explain Kirchhoff's Laws for current and voltage in series and parallel circuits.
- I can build and analyse diagrams of series, parallel, and mixed circuits with reference to Kirchhoff's Laws.
- I can describe how electronic waste is an environmental and environmental health problem and can identify at least one solution to this problem.

Specific Expectations:

F2. investigate, in qualitative and quantitative terms, magnetic fields and electric circuits, and solve related problems;

F2.1 use appropriate terminology related to electricity and magnetism, including, but not limited to: direct current, alternating current, conventional current, electron flow, electrical potential difference, electrical resistance, power, energy, step-up transformer, and step-down transformer

F2.2 analyse diagrams of series, parallel, and mixed circuits with reference to Ohm's law ($V = IR$) and Kirchhoff's laws

F2.3 design and build real or computer-simulated mixed direct current (DC) circuits, and explain the circuits with reference to direct current, potential difference, and resistance

F3. demonstrate an understanding of the properties of magnetic fields, the principles of current and electron flow, and the operation of selected technologies that use these properties and principles to produce and transmit electrical energy.

F3.4 explain Ohm's law, Kirchhoff's laws, Oersted's principle, the motor principle, Faraday's law, and Lenz's law in relation to electricity and magnetism

Description:

In this lesson students learn about Kirchhoff's Laws for current and voltage in series and parallel circuits by physically simulating circuits as a class and then by building their own circuits. **This lesson is intended for the university level.**

Materials

Kirchhoff's Law Activity (Student and Teacher)

Kirchhoff's Laws Activity Materials:

- M&M's or Skittles (lots!)
- Paper cups or small containers for holding the candy
- 1 sign that has a battery on it, with positive and negative terminals
- 4 signs that say "resistor"

Kirchhoff's Laws for Circuits Activity (Student)

Safety Notes

Students are not to consume food in the science classroom. Students must pay attention when using electrical devices.

Introduction

With a partner, students think of all the steps they went through to get to this class today. Make a list. Now they go through the list and add in every single electrically powered appliance or equipment they've used so far today. For example, most of us need an alarm clock to wake up. Was your breakfast cooked in a toaster or microwave? Did you use a coffee pot? Check your phone? Even before you left the house, you used numerous mostly-invisible electric circuits.

If students have ever gone camping or lived in "off-grid", they'll realize that humans had to put much more work into survival before the advent of electricity in the home. Most homes in Canada did not have electricity until almost the 1930's. Now, not only do most homes have complicated circuits with numerous electrical outlets in their homes and businesses, but also we can carry devices with tiny but complex electronic circuitry. We will now learn the basic principles behind all circuits.

Action

You have learned that a basic circuit is made up of a power source (generator, battery, or electrical outlet), conductors, and a "load". In the following activity, you will learn how circuits may be configured in two basic categories, series and parallel, or a combination of the two, to allow the current to flow through, and transfer electrical energy to different devices.

Often we learn about analyzing circuits by drawing diagrams and doing mathematical calculations, without really understanding why certain equations are used. Today we will demonstrate Kirchhoff's laws for Voltage and Current.

Students are to complete Kirchhoff's Law Activity (See Link).

Next, use circuits to prove these laws in the Kirchhoff's Laws for Circuits Activity (See Link).

Activity adapted from http://tap.iop.org/electricity/circuits/117/page_46028.html.

Consolidation/Extension

At the end of the activity, the teacher should help students to consolidate their knowledge by expressing Kirchhoff's Laws for Series and Parallel circuits mathematically.

Kirchhoff's Laws can be stated mathematically in the following manner:

For Series Circuits:

$$I_t = I_1 = I_2 = I_3 = \dots$$

$$V_t = V_1 + V_2 + V_3 + \dots$$

For Parallel Circuits

$$I_t = I_1 + I_2 + I_3 + \dots$$

$$V_t = V_1 = V_2 = V_3 = \dots$$

Exit Card

Summarize Kirchhoff's Current and Voltage Laws for Series and Parallel Circuits. Draw diagrams if necessary.

Further Extension

E-waste is a huge problem, particularly in developing countries. With a partner, write a list of all the electronic waste you have personally generated.

- How many cell phones have you had?
- What did you do with them once they were broken or out of date?
- How old is your computer?
- When did you last upgrade?

Follow these links to uncover the extent of environmental damage we create when we throw out, or even recycle, our electronics (E-Waste Problems Rubric - See Link).

EWaste Republic

<http://interactive.aljazeera.com/aje/2015/ewaste/index.html>

EWaste Dumping Ground

<http://www.cbc.ca/player/play/1305152453>

However, scientists have now developed a circuit board that is biodegradable allowing the constituent metals to be recycled more easily.

New circuit board tech is 90% recyclable, dissolves in water

<http://www.geek.com/science/new-circuit-board-tech-is-90-recyclable-dissolves-in-water-1593346/>

Green Circuit Boards That Biodegrade

<http://cen.acs.org/articles/92/i40/Green-Circuit-Boards-Biodegrade.html>