Science Unit: ***Concepts in Electricity***
Lesson 4: ***Simple Parallel Circuits***

Summary:	Students build a **parallel circuit** that lights a bulb. They use their prior knowledge of building a simple series circuit (lesson 3 of this unit) to **predict** what they think will happen when presented with a parallel circuit containing a greater number of circuit elements. They **test their prediction**.
School Year:	2013/2014
Developed for:	Lord Selkirk Elementary School, Vancouver School District
Developed by:	James Day (scientist); Marie-Christine Michel and Karina Houle (teachers)
Grade level:	Presented to grade 6; appropriate for grades 5 – 7 with age appropriate modifications
Duration of lesson:	1 hour and 05 minutes
Notes:	This lesson is a modification of "Lesson 2: Series and Parallel Circuits" in the "Electricity with Applications" Unit. **It is preferable to use power adapters instead of batteries.** Batteries are not recommended because they can explode when shorted, are expensive and have a short life. Power adapters, on the other hand, are safer, last for years, contain circuits that protect them when shorted and cost much less per year of use. The typical 6-V battery used in schools costs $10 and lasts 1-2 years. A power adapter costs $20 - $30 but lasts for many years. **Safety precaution**: If using batteries, be careful not to short the terminals of the battery as it will damage the battery and there is a danger of explosion. In other words, do not connect the terminals of the battery directly with a low resistance element such as a wire or any piece of metal. Note that voltages less that 24 V are considered safe. Power supplies should be used that have outputs less than 24 V and have current limiting to prevent blowing fuses in the event that outputs are shorted.

Objectives

Students will:

1. Learn how electricity is used in circuits to do work.
2. Identify a parallel circuit.
3. Create a parallel circuit that lights a bulb.
4. Discover how voltage potential drops across a parallel circuit element.

Background Information

This lesson builds upon all that was learned in the previous. In lesson 3, students worked with series circuits; in this lesson, students will work with parallel circuits. The intention is to compare and contrast the properties of the two types.

Vocabulary

Parallel circuit: A circuit in which the components are connected in parallel with one another.

Materials

- power supplies or batteries
- battery holders
- wires
- light bulb holders
- light bulbs
- knife switches

In the Classroom

Introductory Discussion

1. Review the series circuits studied the previous week. Keep returning to the analogy of water flow to help the students build their conceptual model.
2. Short description of other items to discuss or review.

   What is a series circuit? What is a parallel circuit? Electrical current powered by an electrical source such as a battery or power supply travels from one of the two terminals of the source, through one or more circuit elements and back to the power source through the second terminal. The circuit element could be wires, lamps, heating elements, or any number of elements that conduct electricity. The simplest circuit would form a single continuous loop (called a series circuit) from one source to the other, but more complex arrangements are possible,

   Can you think of any circuits that are wired in series? Or in parallel?
3. Briefly describe science experiment/activity.

   Students will gain experience constructing a basic parallel circuit.

   Students will be presented with a question for which they must create and test a hypothesis. Each group will be given a different question to test. At the end of the activity, students will present their results to the rest of the class.
4. Briefly describe the processes of science that the students will focus on (prediction/hypothesis, observations, recording results, conclusions.)
5. Briefly describe safety guidelines.

   If using batteries: Be careful not to short the battery terminals as it will damage the battery and there is a danger of explosion. In other words, do not connect the terminals of the battery directly with a low resistance element such as a wire or any piece of metal.

Science Activity/Experiment

Activity Title: Building and Testing Parallel Circuits

Purpose of Activity: To gain experience building simple series circuits; to test student models of how electricity flows (i.e., hypothesis testing).

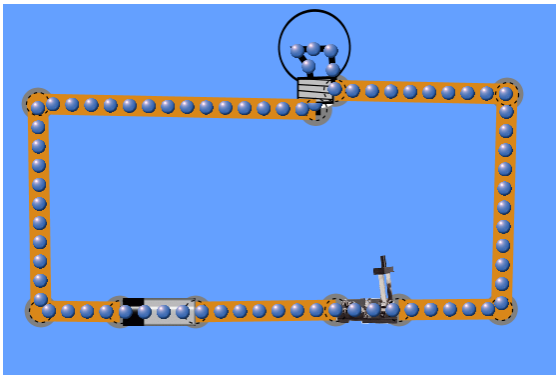
Experimental Observations: This is not an experiment with controls and treatments.

Prediction or Hypothesis: Before students make their prediction (or hypothesis), it helps if they start with a question, or make observations and then ask a question. They will use their prior knowledge from building a simple series circuit to predict what they think will happen when presented with a parallel circuit containing a greater number of circuit elements. They will record their prediction based on the following question: What will happen when…? (See below, starting at 3.a., for the variety of questions that a group might be given).

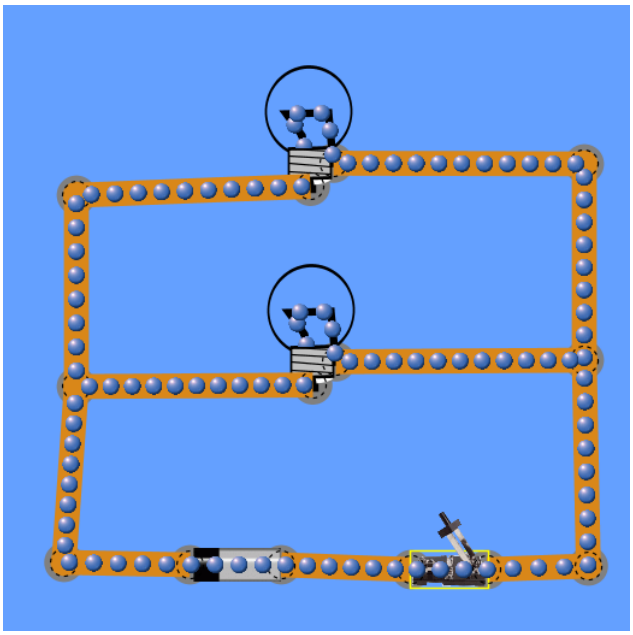
Methods and Instructions:

Set-up prior to experiment: Little circuit kits must be put together so that each group can work with the same type and number of circuit elements (wires, battery boxes and batteries OR power supplies, light bulb holders, light bulbs, etc.) Students will work in groups of two.

1. Working in small groups, students will construct a simple series circuit to light a single light bulb with a battery, as shown in the PhET picture below.



2. Students sketch their circuit into their science notebooks.
3. Groups will then be given one of the following questions. Students will make and record their hypothesis in their science notebooks.
    a. What will happen to the brightness of you bulb if you add a second battery in parallel to your circuit?
    b. What will happen to the brightness of you bulbs if you add a second bulb in parallel to your circuit? (As shown in the figure below.)



    c. What will happen to the brightness of your bulb if you add a second battery and a second bulb in parallel to your circuit?

4. Once students have recorded their hypothesis, they will be provided with the necessary circuit elements to test their hypothesis. Students will record their observation in their science notebooks and explicitly write whether or not their initial hypothesis was correct or not. Be sure to remind students that it is unimportant whether or not their initial hypothesis was correct; what is important is that their hypothesis was tested and that they now have a better understanding of how circuits work. It's always better to know more now than you did before (which sometimes means correcting mistakes in your thinking).
5. Time permitting, students can then be presented with a more complicated series/parallel circuit. If the brightness of a single bulb in series with a single battery is "4", how bright will the second bulb be in a series circuit that contains four batteries and six bulbs? Have some students share their hypotheses with the class. Using the DC Circuit Construction PhET, displayed on a SMARTBOARD, build the circuit in question and test the hypotheses as a group. Time permitting, other circuits can be tested (or re-tested, from the questions covered earlier).

Closure Discussion

1. Did the circuits behave as you originally expected?
2. What other types of circuits can you imagine?

References

http://www.dummies.com/how-to/content/electronics-basics-fundamentals-of-electricity.html

http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc

http://hyperphysics.phy-astr.gsu.edu/hbase/electric/watcir.html#c1

http://en.wikipedia.org/wiki/Series_and_parallel_circuits

Extension of Lesson Plan

1. Use different circuit elements to determine which materials are good conductors and which are poor conductors (i.e., good insulators) of electricity. Materials could include: coins, pencils, paper clips, erasers, nails and screws, paper, cutlery, etc.
2. Use a digital multimeter so that students can measure voltage drops across the bulb and other circuit elements.