Current Electricity	Grade 6 - Electricity and Electrical Devices

Lesson Plan

Safety Notes

When using boiling water, use extreme caution or ask an adult for help.

Do not connect your LEDs directly to batteries over 3V. Do not short circuit your circuits. Be cautious of overheating your circuit.

Description

Students will learn that current electricity is a flow of electrons through a circuit that is in series or in parallel and they will explore the differences between conductors and insulators.

Materials

Conductive and insulating playdough

- Kettle (or saucepan and hot plate)
- Measuring cups
- Mixing spoons
- Plastic mixing bowls
- Flour
- Salt
- Sugar
- Oil (Canola)
- Food coloring (optional)
- Water (tap)
- Deionized or distilled water
- 9V batteries
- alligator clips (alternative: wire or paperclip)
- LED

Paper Circuit

- Paper or cardstock
- aluminum or copper tape (aluminum foil will also work)
- regular tape
- 3V coin battery
- LED
- heavy-duty plastic clip

Science Background

Electricity is the flow of particles called electrons. Electrons are negatively charged and move towards a positive charge. In static electricity, the electrons will collect on the surface of an object until it can move towards a positively charged object. However, the focus of this lesson will be on current electricity.

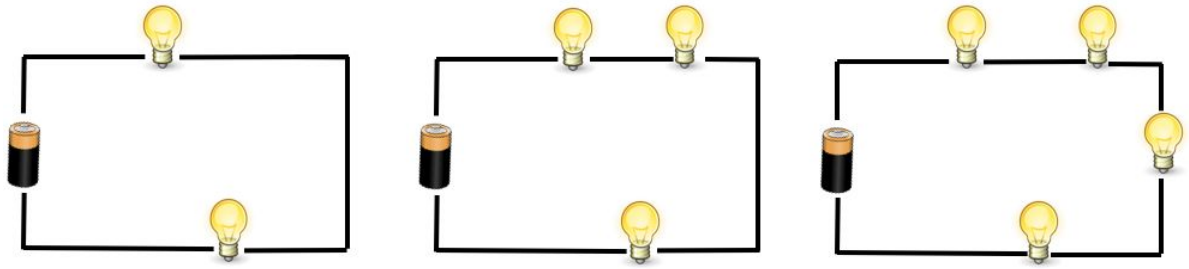
Current electricity is the movement of electrons (also known as the flow of electrons) through conductive material. There are many types of materials that are good electrical conductors; for example, most metals like copper and aluminum, plants, living things, etc. Opposite to a conductor is an insulator. Insulating materials are materials that will not allow for the flow of electrons to pass through; for example, rubber, paper, glass, wood, etc.

The energy or electricity we use everyday follows a path called a circuit. An electrical circuit is made up of three main parts: an energy source (ex. a battery), a load (ex. a light bulb or motor) and something to connect it all together (ex. wires). For a circuit to work, the electrons must be able to flow from the battery through the wires to the light bulb and back to the battery. This is called a closed circuit. If there's a break in the loop, the load will not work. This is called an open or broken circuit. When you flick the light switch to turn on a lamp, you are closing the circuit allowing the electrical current to reach the light bulb and turn it on; when the switch is turned off, the circuit is open which prevents the flow of electrons from reaching the load (the light).

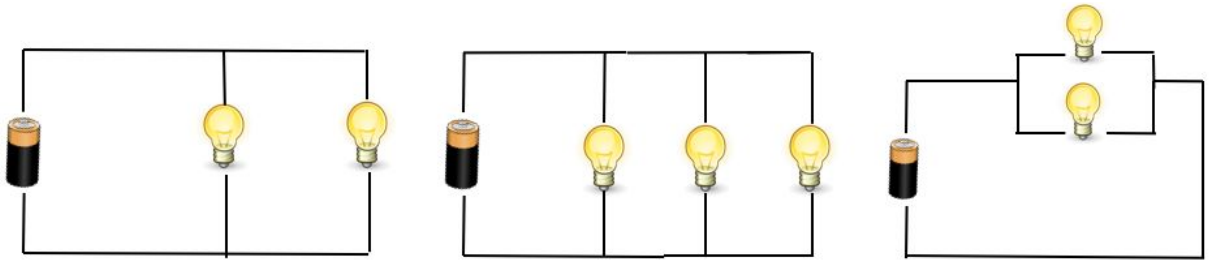
There are two types of circuits: series and parallel. A circuit in series only has one path to follow, and there can be more than one load on this path. One common example of a circuit in series are Christmas lights. The circuit follows one path and all the light bulbs share the voltage. The difficulty with this kind of series is if one light bulb burns out, the circuit is broken and none of the bulbs will be able to light up. The more loads, the dimmer the lights will be, since each load has to share the voltage.

A parallel circuit contains more than one load and has more than one path on which electrons can flow. Since this circuit has more than one available path for the electrons to flow through, one bulb burning out won't prevent the other loads from receiving current; that is, just because one bulb burns out, doesn't mean all the others will too! Additionally, the loads in a parallel circuit don't have to share the voltage, so it doesn't matter how many bulbs you add - they'll all be equally lit.

Series circuit



Parallel circuit



Activity Procedure

Conductivity vs insulation

1. Is playdough conductive?
2. Two different types of play-dough will be made to test for conductivity.
3. Look at the play-dough recipes, what is different and what is the same between the two.
4. Hypothesize if any will conduct electricity?

Recipe 1

2 cup white flour
1 cup salt
4 tablespoon cream of tartar (find it in the spice section)
2 tablespoon oil
2 cup boiling water
food coloring

1. Dissolve salt in boiling water.
2. Mix the rest of the ingredients in a bowl.
3. Add the water/salt mixture and stir.
4. When the dough is cool enough to handle, knead the dough by hand.
5. Add extra four if the mixture is too sticky.
6. Break into batches to make different colours if desired. (Note: If using one colour, it is easier to to add the food coloring to the water/salt mixture)

Recipe 2

1.5 cup of flour
0.5 cup sugar
3 tablespoons oil
0.5 cups deionized/purified water

1. Rinse out the kettle with deionized water before boiling water in it.
2. Dissolve the sugar in the boiling water.
3. Mix the rest of the ingredients in a bowl.
4. Add the water/sugar mixture and stir.
5. When the dough is cool enough to handle knead the dough by hand.
6. Break into batches to make different colours if desired. (Note: If using one colour, it is easier to to add the food coloring to the water/salt mixture)

Which dough is insulating and which is conductive?

1. Look at the two ends of an LED, the short (negative polarity) and the long (positive polarity) (Note: The LEDs CANNOT be attached to the batteries directly because the current will be too high and burn out the LED, which would smell bad at the best and pop dangerously at the worst.)
2. A battery has two ends, a positive and negative side. These sides are also called electrodes, to the battery, attach one end of the alligator clip (or the alternative wire or paperclip, the playdough can be connected directly to the battery but note it may cause some corrosion over time) to each electrode.
3. To the other end of the alligator clip add some of the playdough of your choice.
4. Which playdough is conductive and which is an insulator.
5. Extra activity: with the conductive playdough add various materials to the circuit to determine whether they are conductive or non conductive (ex. a spoon, a stick, plastic etc.)

Paper Circuit

1. What is the configuration of series circuits (components are connected together) and parallel circuits (the components are like rungs on a ladder).
2. Review polarity with regards to the LEDs from the previous activity. They will only work in one direction.
3. The templates can be used in full or figure out different configurations to set up the circuits to do various functions.
4. Lay down aluminum foil and tape it down, following a path on a piece of paper.
5. When laying down the conductive material, use a continuous piece of tape until you reach the point where you will insert your LED. Fold through the corners until you reach the end of a section.
6. Simple series circuit: one loops with LED in series. Parallel circuit: two parallel lines of conductive tape, LEDs bridging the gap between the two lines. Switch: have an extra gap in

your circuit that can be closed with a piece of conductive tape. Slide switch: several pieces of conductive tape that will close the circuit when pressed down as a finger slides over.

7. You can search paper circuit templates online to see more elaborate projects. Use the very simple template included with this activity to get started.
8. Experiment with different types of conductive materials: copper, aluminum, etc. Try making a paper circuit with graphite by drawing heavy graphite lines with a graphite pencil. How dark do the lines have to be? What type of pencil works best? 9B has much more graphite than 2HB.

Debrief

Conductivity vs. Insulation

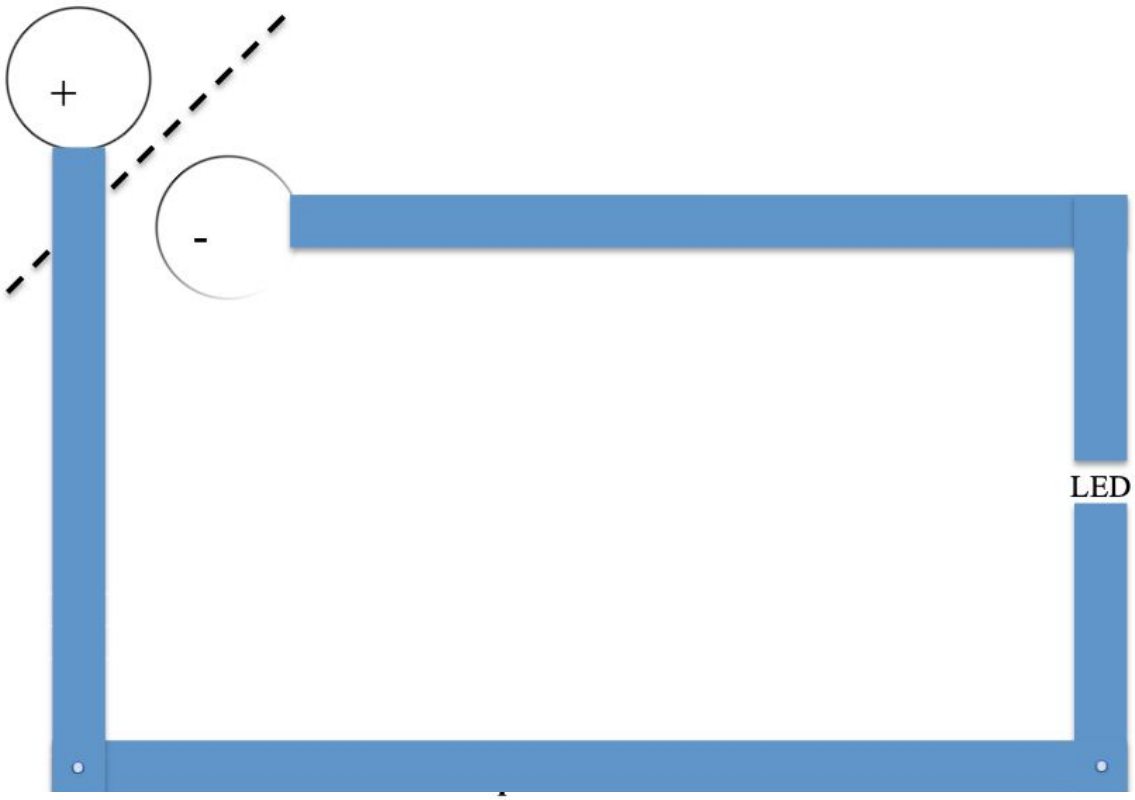
It is commonly believed that water is conductive, however pure water is an insulator. It is the minerals found in everyday water that allow electrons to travel through ions in the water and complete the circuit. One of the doughs prepared contains a lot of salt, making it conductive. The other dough contains sugar and deionized water, making it an insulator; without the salt or minerals there is no path for the electrons to follow. However, contamination may occur in which case, you may find that the insulating dough was a little conductive; if this was the case the intensity of the LED should be different, less bright with the insulating dough.

Paper Circuit

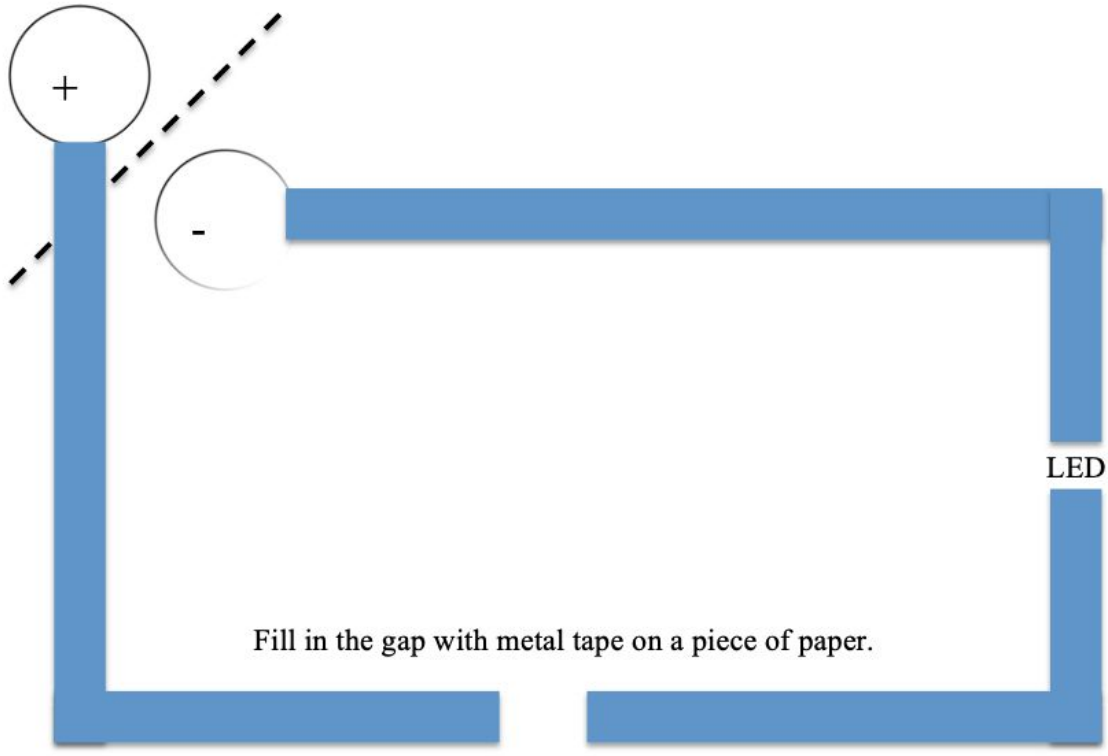
Contrary to the name pencil "lead", pencils actually contain graphite and clay. Graphite is made of carbon atoms with a specific particle structure; each atom is capable of binding in its own specific way to other atoms this allows them to make different shapes and microscopic structures. The structure that the carbon atom takes that creates graphite allows electrons to pass from one atom to to the next creating a flow of electrons, thus making graphite a conductive material. As opposed to the structure carbon takes to make diamonds which does not allow electrons to easily pass through the material and so diamonds although also made of carbon are non-conductive.

A finger is used as a switch, because the human body is a great conductor of electricity and the finger used is capable of closing the circuit when pressing down on the aluminum foil. The human body is made up of many different particles, water being one of them, and in that water are many minerals and salts. Similarly to the playdough experiment, salt is a great conductor as it allows electrons to travel from one particle to the next creating electrical current. One thing to keep in mind is that not all materials will pass electricity equality and some will be better, like copper, and some less conductive like salt.

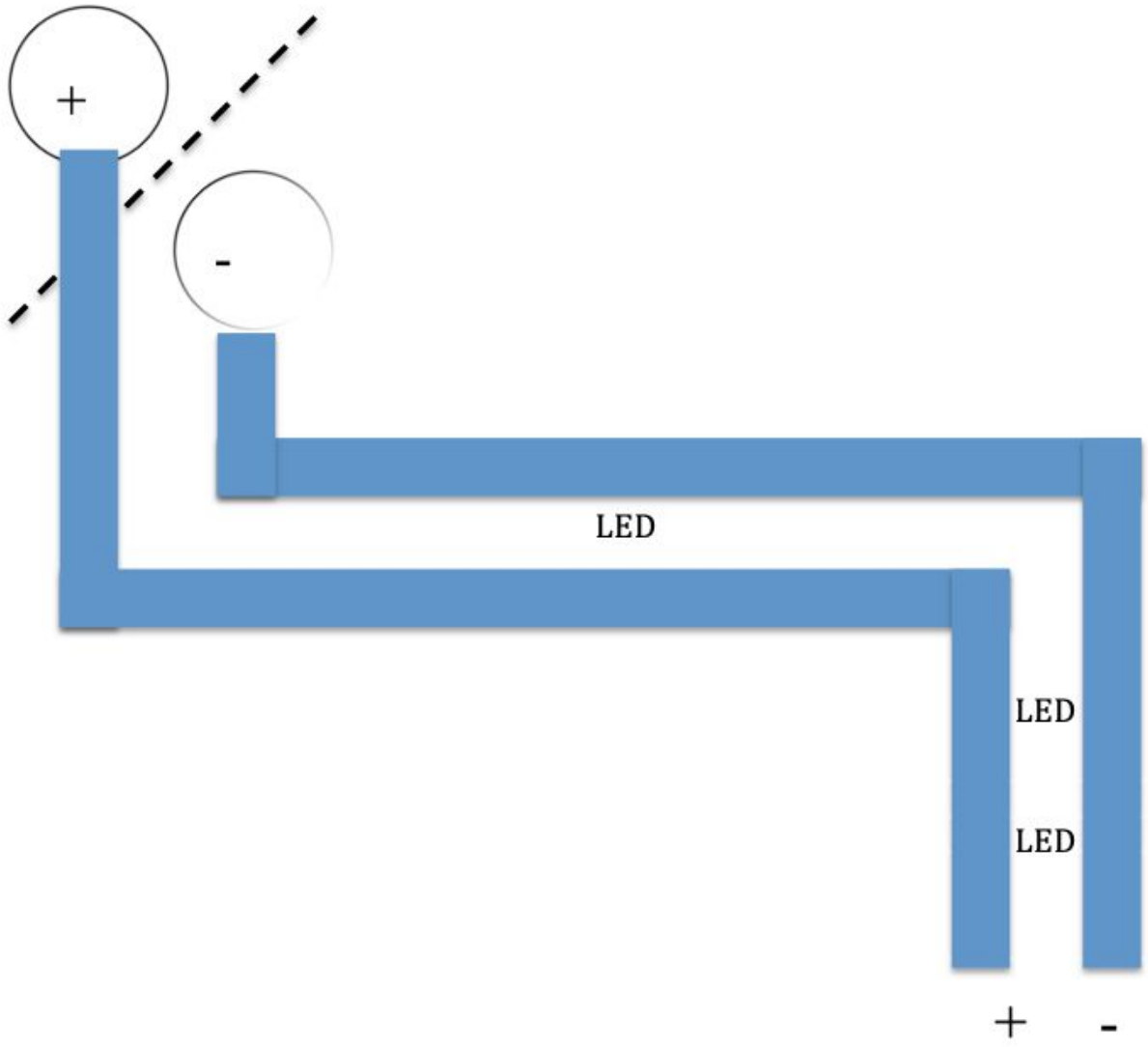
Simple Paper Circuit



Simple Circuit with Switch

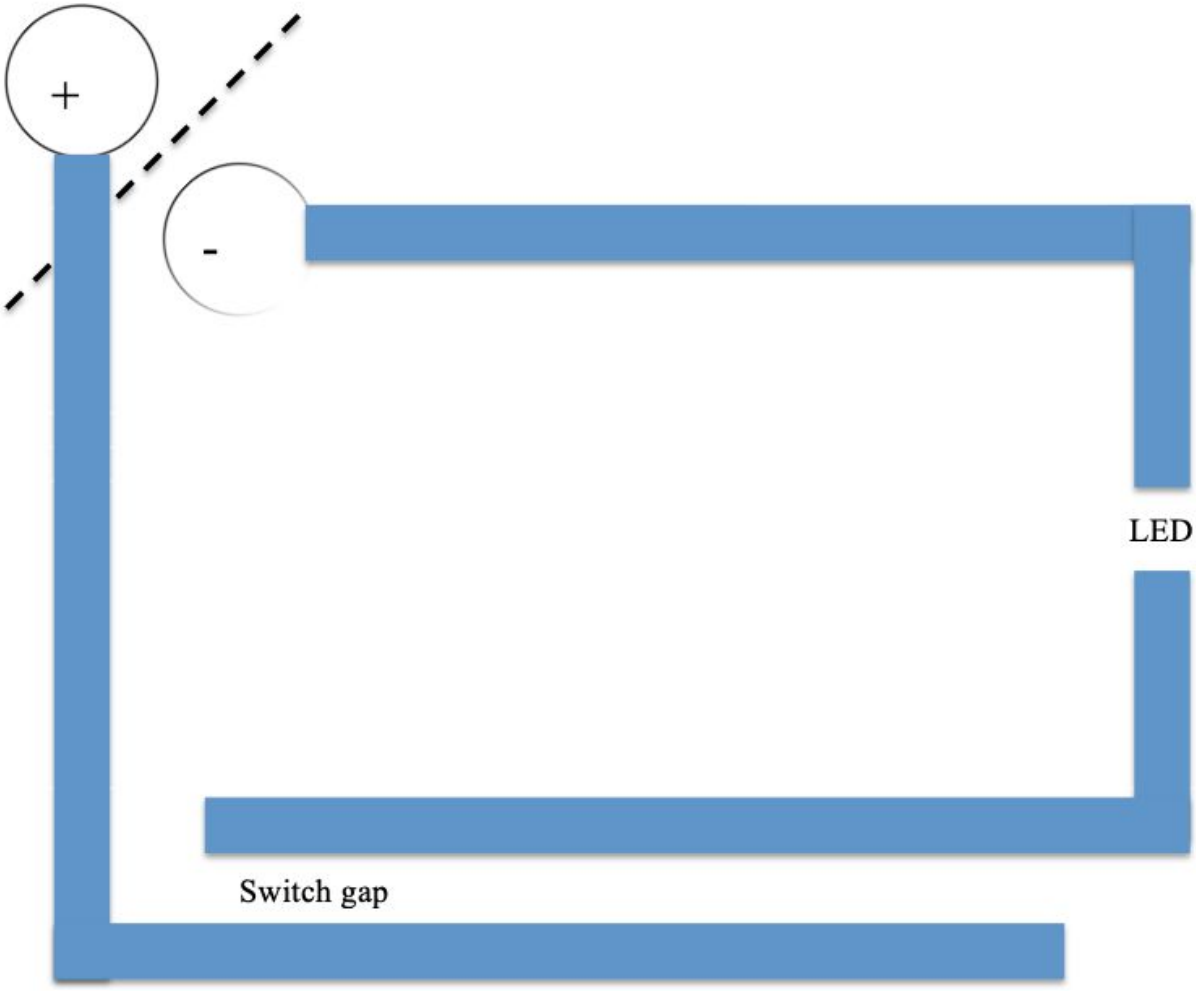


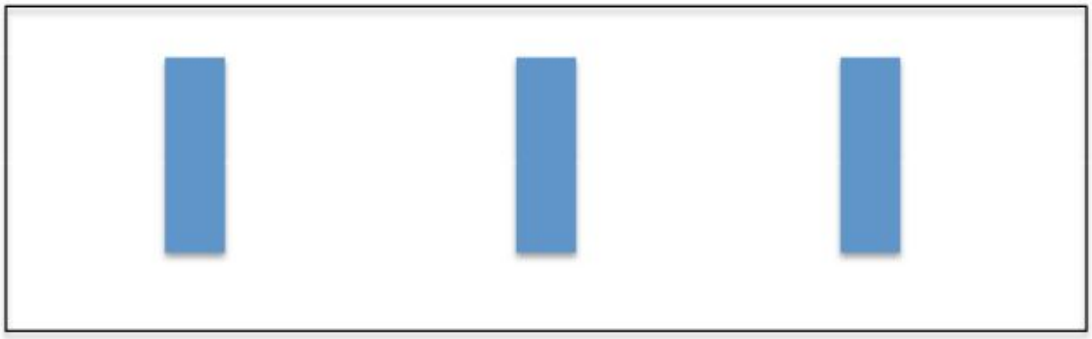
Parallel Circuit



This is a simple parallel circuit. This template could be used to do something like traffic lights that light up with pressure if the LEDs are attached to a separate piece of paper. Google traffic light paper circuit.

Circuit with Blinking Light Slider





Switch Connectors

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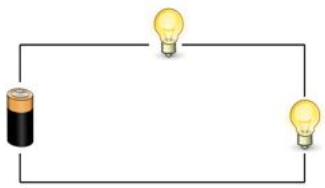
1. It is preferable to connect bulbs in series or in parallel? (Hint: What if one bulb burns out?)
a) Series
b) Parallel
c) Both series and parallel
d) Neither series nor parallel

2. Batteries are most efficient when connected in_____ (Hint: Which method doubles the voltage?)
a) Series
b) Parallel
c) Either series or parallel
d) Neither series nor parallel

3. Which is the most cost efficient connection? (Hint: In which method do bulbs share the voltage?)
a) Series
b) Parallel
c) Either series or parallel
d) Neither series nor parallel

4. For the following circuits, state if the circuits are series, parallel, or both:



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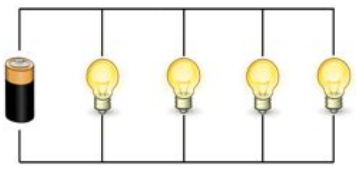

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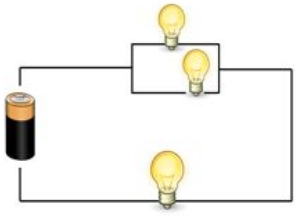

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5. In the space provided, draw each of the following circuits:

a) A series circuit with 2 light bulbs and 1 battery

b) A parallel circuit with 3 light bulbs and 1 battery

c) A series circuit with 5 light bulbs, 1 battery, and 1 switch (in the "off" position).

d) A parallel circuit with 4 light bulbs, 1 battery, and 1 switch (in the "off" position).

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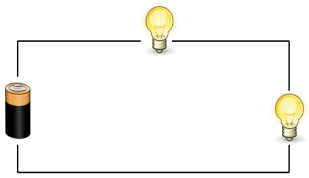
1. It is preferable to connect bulbs in series or in parallel? (Hint: What if one bulb burns out?)
a) Series
b) Parallel
c) Both series and parallel
d) Neither series nor parallel
Explanation: Bulbs are connected in parallel so that even if one of the bulbs blows out, the others continue to get a current supply.

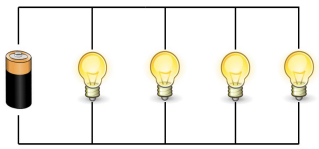
2. Batteries are most efficient when connected in_____ (Hint: Which method doubles the voltage?)
a) Series
b) Parallel
c) Either series or parallel
d) Neither series nor parallel
Explanation: Batteries are generally connected in series so that we can obtain the desired voltage since voltages add up once they are connected in series.

3. Which is the most cost efficient connection? (Hint: In which method do bulbs share the voltage?)
a) Series
b) Parallel
c) Either series or parallel
d) Neither series nor parallel
Explanation: The advantage of series-connections is that they share the supply voltage, hence cheap low voltage appliances may be used.

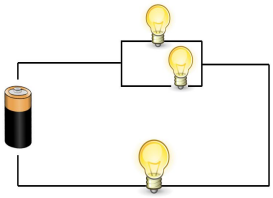
4. For the following circuits, state if the circuits are series, parallel, or both:



Series



Parallel

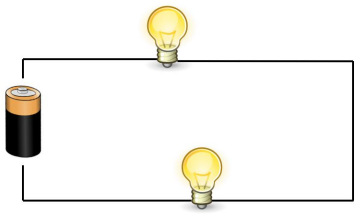


Both

5. In the space provided, draw each of the following circuits:

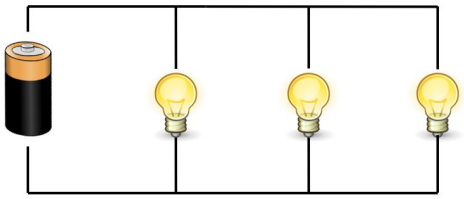
a) A series circuit with 2 light bulbs and 1 battery

Example:



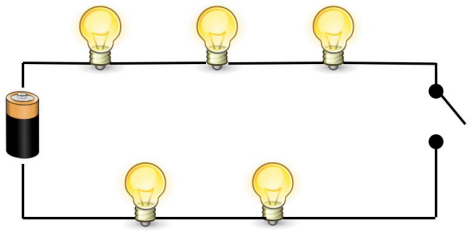
b) A parallel circuit with 3 light bulbs and 1 battery

Example:



c) A series circuit with 5 light bulbs, 1 battery, and 1 switch (in the "off" position).

Example:



d) A parallel circuit with 4 light bulbs, 1 battery, and 1 switch (in the "off" position).

Example: