

# Simple Circuits

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<b>Strand</b>	Force, Motion, and Energy
<b>Topic</b>	Constructing circuits
<b>Primary SOL</b>	4.3 The student will investigate and understand the characteristics of electricity. Key concepts include b) basic circuits.
<b>Related SOL</b>	4.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which a) distinctions are made among observations, conclusions, inferences, and predictions; m) current applications are used to reinforce science concepts.

## Background Information

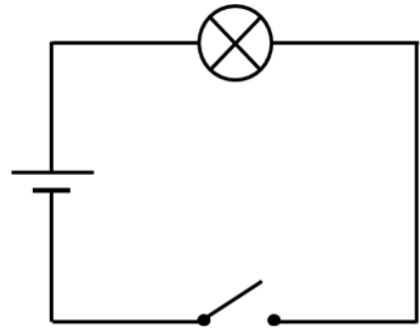
Electricity is energy that produces light, heat, or motion. When electrons are transferred from atom to atom, they produce electric energy. As the electrons move from one atom to the next, they form electrical currents. In order to bridge energy and use it to power machines and appliances, electricity is sent through conductors (usually wires) to the appliance, and then back from the appliance to the electrical source. A circuit is formed when an electric current makes a complete path from the electrical source, through the load, and back to the source. There are four common kinds of electrical circuits.

- 1) Open circuit: If the circuit becomes disconnected and the electricity is not able to pass through it, the circuit is called an open circuit. At this point, the appliance will not turn on. In a circuit with a switch, the circuit will be open whenever the switch is open.
- 2) Closed Circuit: A closed circuit is formed when the conductors are reconnected and the electricity is able to flow through the circuit again.
- 3) Series Circuit: When multiple loads are connected to the same conductor so that electricity must travel through the first load in order to reach the second load, the circuit is called a series circuit.
- 4) Parallel Circuit: In contrast, a parallel circuit is formed when multiple loads are connected to the same source, but have their own conductors. In a parallel circuit, each load functions independently of the other loads, but in a series circuit, each load relies on the others for its electric supply.



## Materials

- One simple circuit kit for each group in your class.  
Each kit should include:
  - one D-cell battery
  - four wires, stripped on each end
  - one paper clip
  - two more paper clips or brass brads
  - two light bulb holders
  - two light bulbs



## Vocabulary

*circuit, closed circuit, open circuit, series circuit, parallel circuit, switch, electric current*

## Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

### Introduction

1. Ask students to look around and name objects in their classroom that require electricity. Discuss how electricity and electrical appliances have changed work at home and school. What jobs/activities have these appliances simplified, changed, or replaced?
2. Ask students to define electricity. Re-define electricity for students:  
Electricity is a kind of energy that makes heat, light, and motion.
3. Discuss where electricity comes from and how it travels: describe how it is produced by a generator at a power plant, travels through the Co-op's electric lines to substations and transistors, and then to the member's meter, where it is delivered to students' homes and schools.

### Procedure

1. Explain that electrical appliances are powered by electricity which travels in a circuit. Reference the Background Information section as necessary.
2. Explain to students that everything is made up of tiny particles called atoms. At the heart of each atom is a group of protons which form a nucleus. Around the nucleus swirls a group of electrons which orbit much like a miniature solar system. Every atom wants to have the same number of electrons as it has protons. However, some electrons have more protons than electrons. When this happens, the atom will try to take an electron from another atom. Electricity is formed when a long string of atoms try to send electrons to each other. A power source like a battery or generator sends electrons into a wire. The atoms in the wire push their electron on to the next atom so they can take the electrons from the battery. As the electrons move down the line of atoms in the wire, they work like dominoes, pushing electrons from one atom to the next. This current of electrons is called electricity, and it is what we use to power our houses and schools.
3. Explain the three primary components of an electrical circuit.  
Electrical Source: a battery, generator, or electrical outlet



Conductors: wires or other objects that carry electricity to or from the electrical source

Load: an object being powered by electricity – in our case, a light bulb or fan.

4. As you define each component of a circuit, show the item to the class.
5. Divide students into groups and have them construct simple circuits, using the Build a Simple Circuit instruction sheet, out of a battery, a light bulb, and two pieces of wire. Check each group to make sure their circuits are connected correctly and all bulbs are lit. **10 minutes**
6. Following the cues in the instructions, have students add switches to their circuits. **3 minutes**
7. Explain the difference between an open circuit and a closed circuit, using the switches as examples. Also show them how a circuit opens when a wire is disconnected from the circuit.

If the circuit is open, the electrical current will not enter the circuit, and the appliance will not work. However, as soon as the circuit is closed (reconnected) with an object that conducts electricity, the light bulb will turn back on.

8. Have the students follow their instruction sheets to create series circuits. **10 minutes**  
In a series circuit, the electricity travels from the source to the first bulb, then on through the second bulb, and back to the source.
9. Have students remove one bulb from their circuit. The other bulb will turn off. **1 minute**
10. Ask student to explain why the light turned off.

When student remove the bulb, they break the circuit. The electrical current is not able to flow in a complete circle, so it does not power either bulb.

11. Have students work to create a circuit that prevents this problem. If they need help, have them follow their instructions to create a parallel circuit. **10 minutes**  
Students' series circuit were composed of only one circuit per power source. However, in a parallel circuit, each bulb has a separate connection with the electrical source. Therefore, students' parallel circuits are composed of two individual circuits.
12. Have students remove one bulb from their parallel circuit. The other bulb will remain lit. **1 minute**

This time when students remove the bulb, only one circuit is broken, and the other circuit remains closed. The electrical current is still able to flow from the battery, through the bulb, and back to the source. Therefore, the second bulb remains lit because its circuit is still closed.

### Conclusion

1. Ask students the following questions for class discussion:
  - What do the bulbs in a series circuit share?  
Bulbs in a series circuit share conductor wires and a power source.
  - What do the bulbs in a parallel circuit share?  
Bulbs in a series circuit share a power source, but have separate conductor wires.
  - In a series circuit, why did removing one bulb turn off the other bulb?



The conductor wires in the circuit did not connect to each other without the light bulb.

- In a parallel circuit, what would you have to remove to turn off both bulbs?  
Students would have to remove the battery in order to turn off both bulbs.
- Why does electricity flow through the light bulbs?  
The bulbs are conductors, and provide an easy path for the electrical current to get from the negative to the positive side of the battery.
- Give examples of a series circuits and a parallel circuit in your classroom.

## Assessment

### • Questions

- What is an open circuit?  
A circuit with disconnected conductor wires is called an open circuit.
- What is a closed circuit?  
A closed circuit provides a complete path for the electricity to travel both from and back to the power source.
- What is the main problem with a series circuit?  
If one appliance in a series circuit breaks, then every appliance connected to the circuit will lose power.
- What is different about a parallel circuit?  
A parallel circuit provides a separate power source connection for every appliance.
- How does this difference solve the problem with series circuits?  
Since every appliance has its own connection to the power source, when one appliance breaks, the others will still have functional connections, and will continue to work properly.

### • Other

- Have each student write a paragraph, draw a diagram, or create a video explaining the four different kinds of circuits.
- Have students complete the What's Wrong with this Circuit worksheet.

## Extensions and Connections (for all students)

- Have students identify parallel and series circuits in the electrical objects in their homes, school, or town.
- Have students complete the Appliance Energy Use Calculations Worksheet. Consider dividing the assignment between several days so students add new information for one appliance each day. At the end of the unit, have students total their electricity usage.
- Have students work together to make their own electricity usage chart by auditing their classroom energy. Students may gather appliance energy information using the How to Read an Appliance Label instruction page.
- Have students write a paragraph explaining why a specific invention uses a series circuit instead of a parallel circuit, or vice versa.



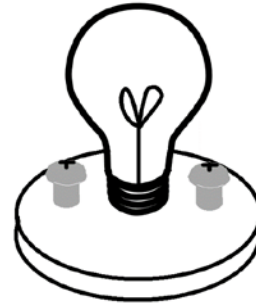
### **Strategies for Differentiation**

- Allow students to use an audio recorder or a video recorder.
- Give clues to struggling students that point them in the right direction when building their circuits.
- Work with struggling students in small groups to provide extra guidance as they assemble circuits.
- Place struggling students in groups with gifted or excelling students, and have them work together



# Build a Simple Circuit

1. Collect your materials.
  - 1 battery
  - 1 light bulb and bulb holder
  - 3 plastic-coated wires
  - Tape

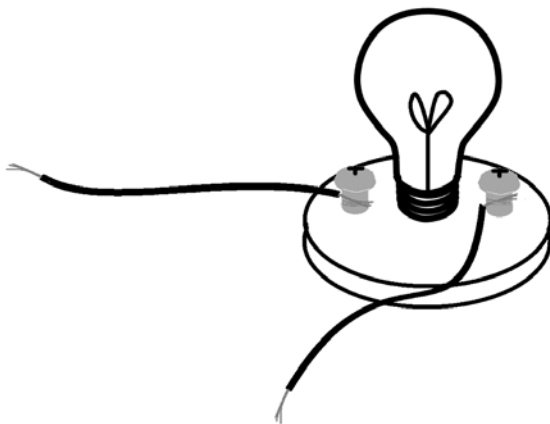


2. If the bulb is not already in the holder, screw it into place.

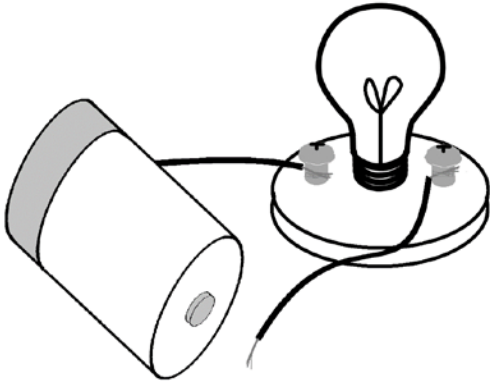
3. Carefully use your scissors to strip about ½ an inch of the plastic coating off of the two ends of each wire.



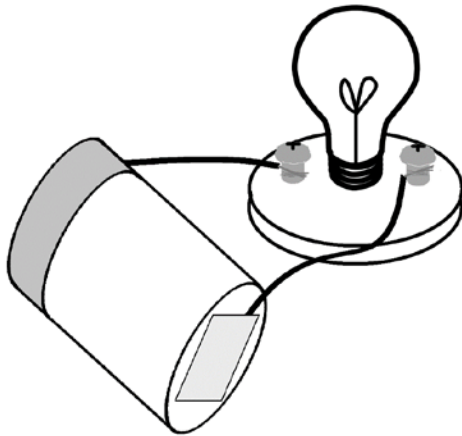
4. Attach one wire to each mount on the bulb holder by wrapping the wire twice around the metal screw.



- Using tape, attach the other end of one wire to the negative end of the battery.



- Then tape the free end of the second wire to the positive end of the battery.

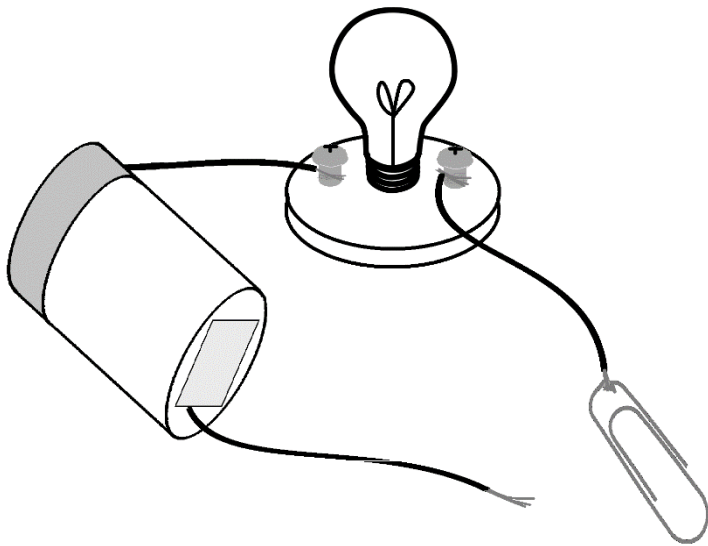
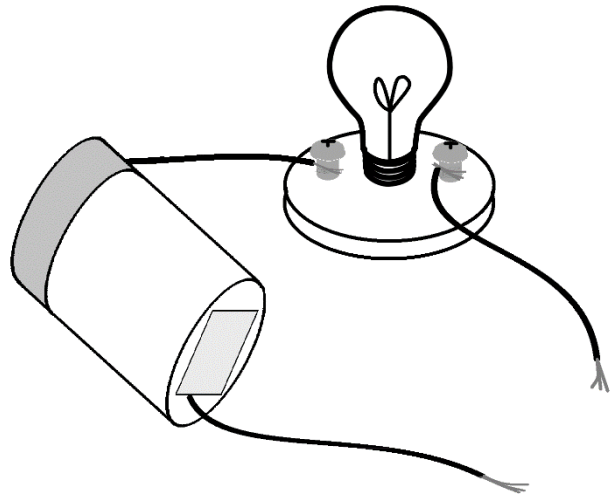


- See what happens.



# Adding a Switch to Your Circuit

1. Strip the plastic coating off of one more piece of wire.
2. Disconnect one wire from the light bulb holder and insert one end of the new wire in its place.

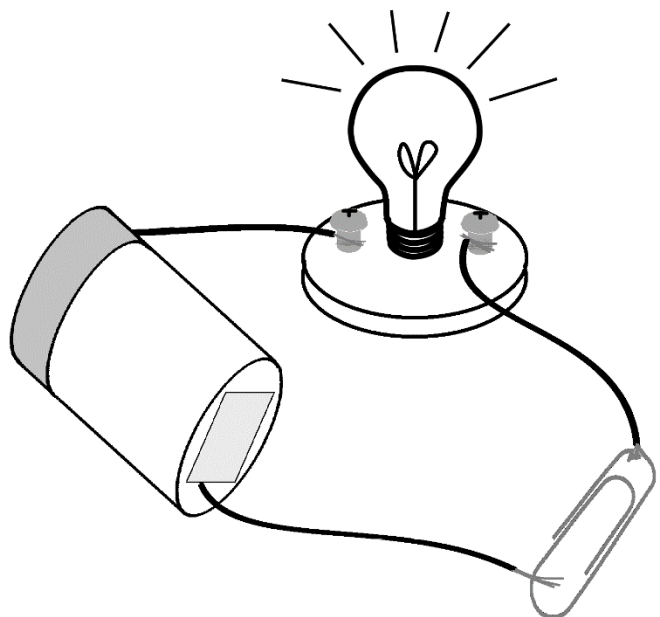


3. Wrap the other end of the new wire around a paper clip.

4. Touch the disconnected end of the first wire to the paper clip.
5. See what happens.

When the paper clip is not touching the wire, you have an open switch, which creates an *open circuit*.

When you touch the wire to the paper clip you close the switch, and make a *closed circuit*.



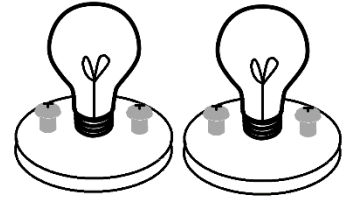


# Build a Series Circuit

1. Gather more materials.
  - 1 light bulb and bulb holder
  - 1 plastic-coated wire.
2. Screw second bulb into its holder.
3. Strip the ends of the fourth wire, just like you did for the other three.

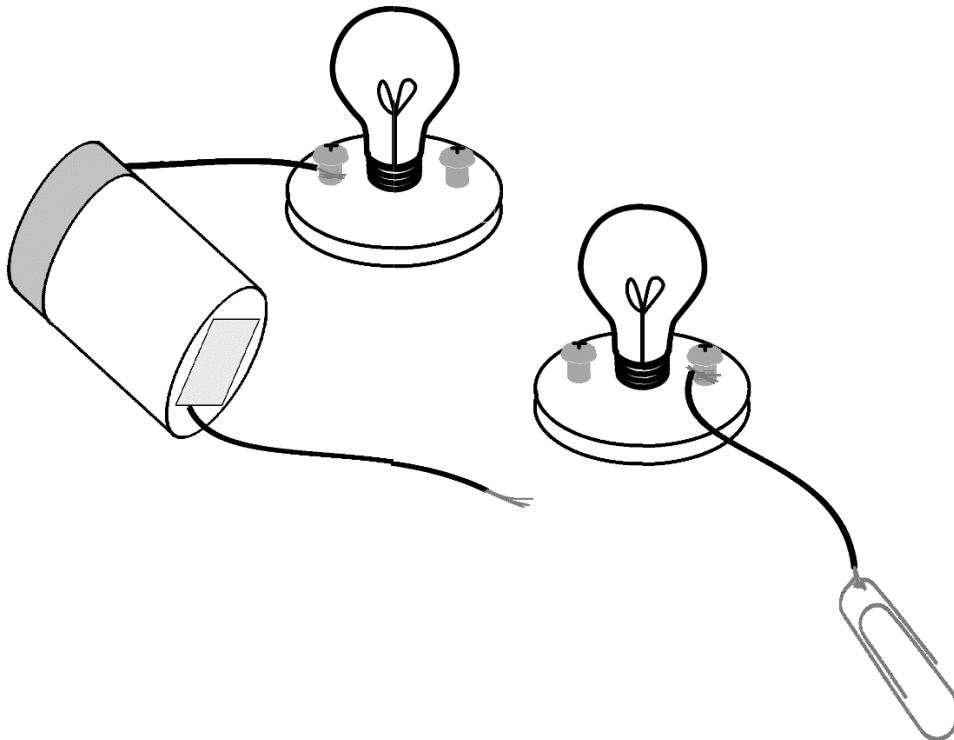


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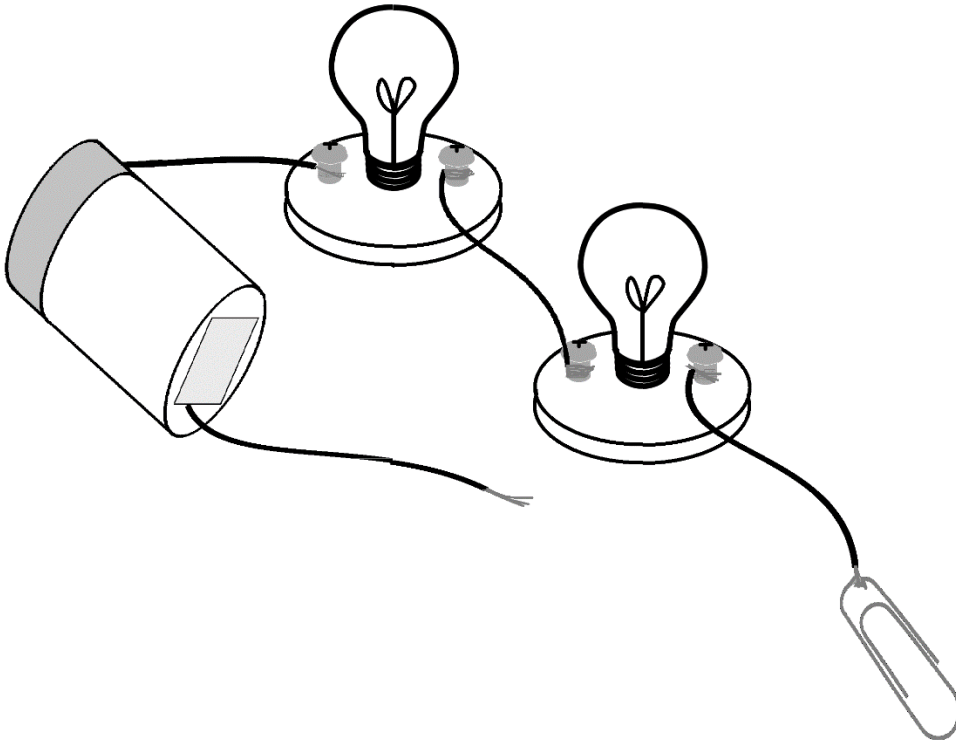


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4. Disconnect one wire from the first light bulb holder, and attach it to the new holder.

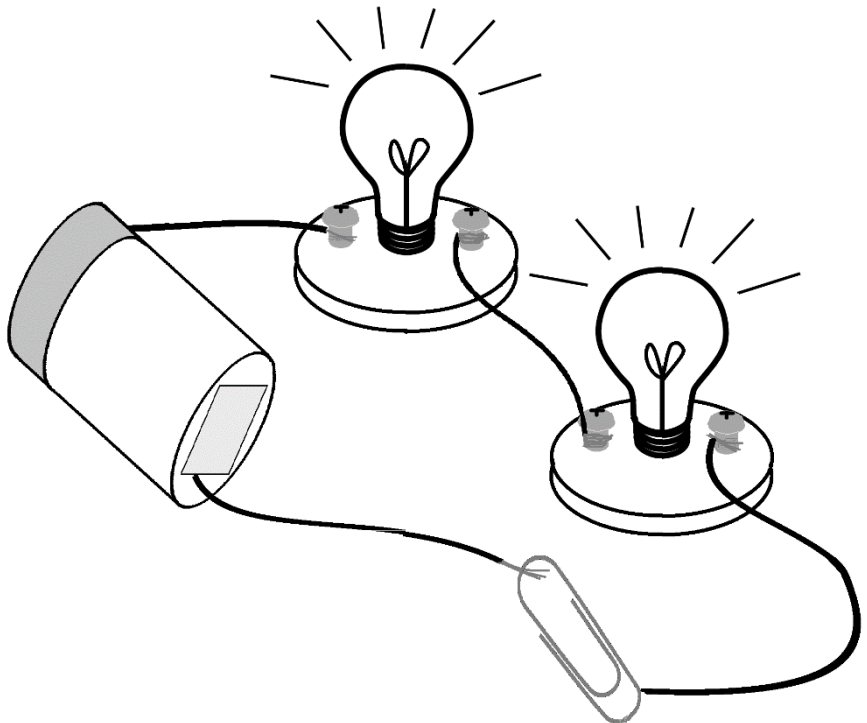


5. Attach the ends of the new wire to the empty heads on the two bulb holders.



6. Close the paper clip switch.

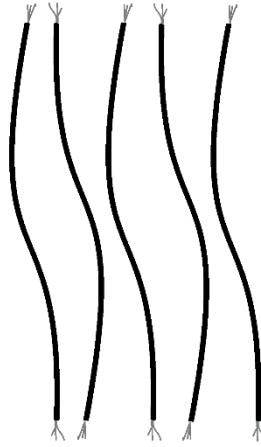
7. Watch what happens.



# Build a Parallel Circuit

1. Disassemble your parallel circuit and organize your pieces. You will need:

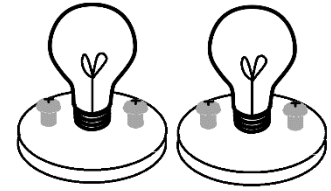
- 1 battery
- 2 light bulbs and 2 bulb holders
- Five plastic-coated wires with stripped ends
- Tape



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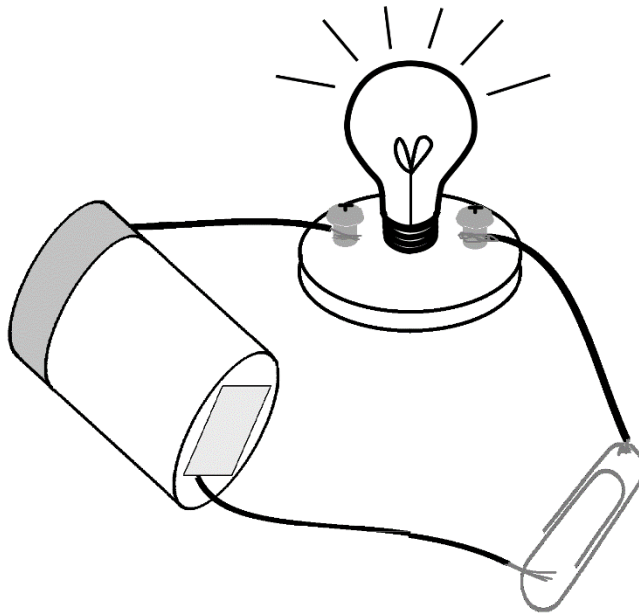


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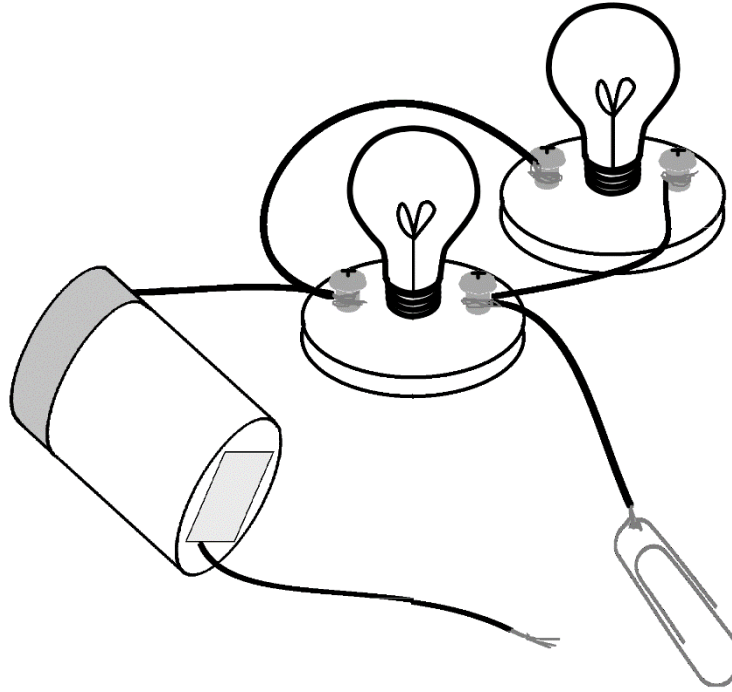


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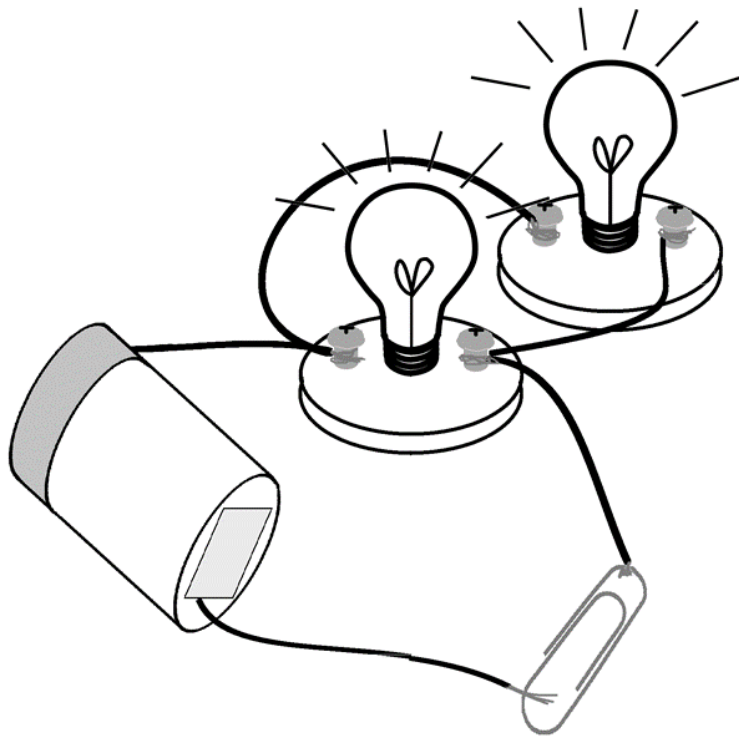
2. Follow the instructions pages 1-3 to build another simple circuit with a switch.
3. Close the switch and make sure the bulb turns on.



4. Open the switch. Then connect the second bulb to the circuit by attaching two wires between the two bulb holders.

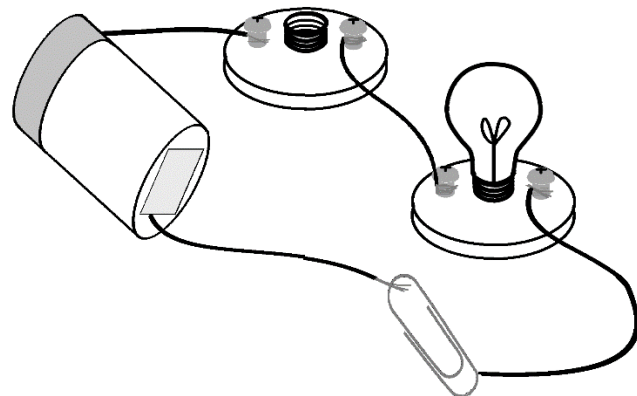
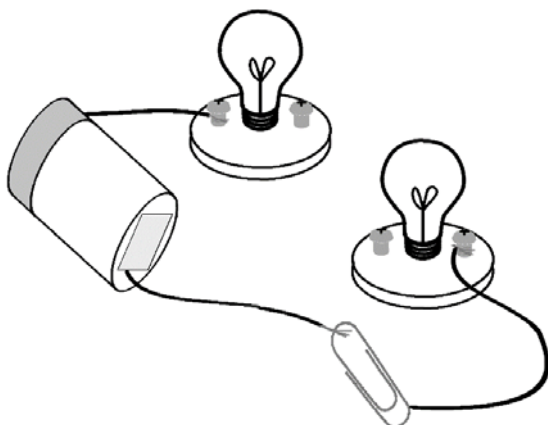
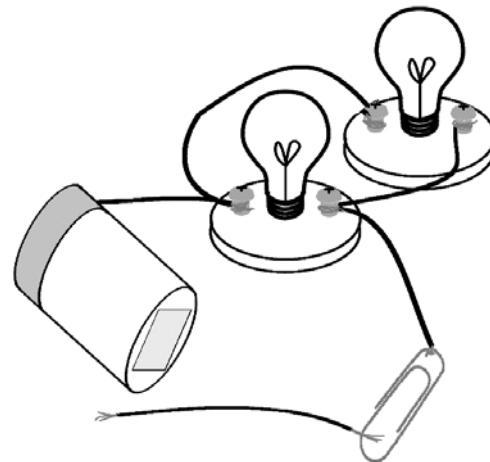
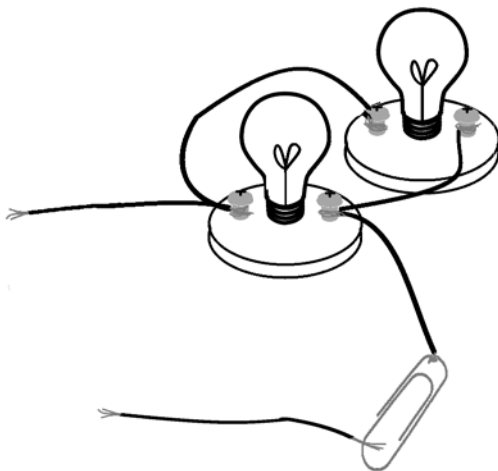
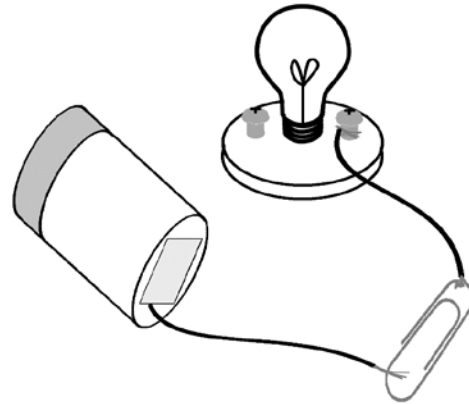


5. Close the switch.
6. See what happens.



# What's Wrong with this Circuit?

None of these circuits are working. Spot what is wrong with each of circuits and draw the missing pieces. Once it is ready to work, draw light around each bulb.



# Answer Key: What's Wrong with this Circuit?

None of these circuits are working. Spot what is wrong with each of circuits and draw the missing pieces. Once it is ready to work, draw light around each bulb.

