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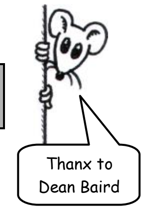

CONCEPTUAL PHYSICS	Activity

35.2 Electric Circuits

AN OPEN AND SHORT CASE

Purpose

In this activity, you will explore open circuits and short circuits.

Required Equipment and Supplies

2 D-cell batteries
5 connecting wires
2 miniature bulbs (1.5-volt or 2.5-volt flashlight bulbs)
2 miniature bulb sockets
DC ammeter (0–5A)

Discussion

Electrical circuits are all around us. (We often appreciate them most when the power goes out.) Most circuits work perfectly well (when power is available). But electrical circuits *can* fail. Two common modes of circuit failure are *open circuits* and *short circuits*. In this activity, we will learn how these circuit failures are similar and how they are different.

We will be using an *ammeter* to help us with this investigation. An ammeter is a simple device used to measure electric current—the rate at which charge flows through a circuit. Current is measured in amperes ("amps").

Procedure

Part A: Open and Short Circuits

Step 1: Arrange a simple circuit using two batteries, a bulb, an ammeter, and three connecting wires as shown in Figure 1. If the circuit is working, the bulb will light and some amount of current will register on the ammeter. It should be less than 1 amp.

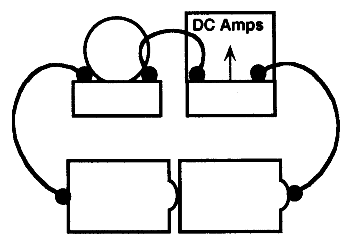

Figure 1. Simple circuit

Step 2: Predict what would happen to the simple circuit if one of the wires were disconnected at one point in the circuit. (Don't touch the circuit yet—predict first!)

1. What will happen to the bulb and what will happen to the reading on the ammeter (compared to what happened in Step 1)?

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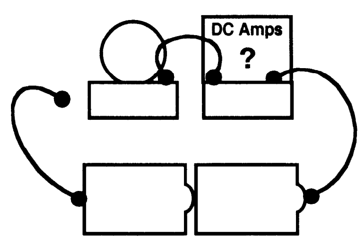

Figure 2. Open circuit

Once you've made your prediction and discussed it with your partner(s), disconnect a wire as shown in Figure 2. This is an *open circuit*.

2. Record your observations.

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Step 3: Predict what would happen to the simple circuit if an additional wire were added to the circuit so as to connect the terminals of the bulb to each other as shown in Figure 3. (Don't touch the circuit yet—predict first!)

3. What will happen to the bulb and what will happen to the reading on the ammeter (compared to what happened in Step 1)?

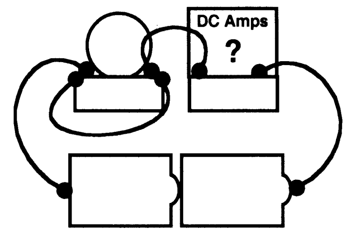

Figure 3. Short circuit

Once you've made your prediction and discussed it with your partner(s), add a wire as shown in Figure 3. This is a *short circuit*.

4. Record your observations.

Step 4: One of these circuit failures is said to have almost *no electrical resistance* and one is said to *have infinite electrical resistance*. Electrical resistance is inversely proportional to electrical current in a simple circuit.

5. Which circuit failure has no current and therefore infinite electrical resistance?

6. Which circuit failure has a large amount of current and therefore almost no electrical resistance?

Part B: Short-Circuited Series Circuit

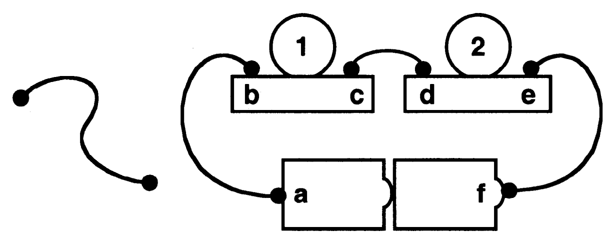

Figure 4. Series circuit and additional wire

Step 5: Arrange the series circuit shown in figure 4. Notice that bulbs 1 and 2 light up. Notice there is an additional wire not yet in the circuit.

Step 6: Add the additional wire to the circuit, connecting point a to point b. Notice that both bulb 1 and bulb 2 remain fully lit.

Step 7: Now use the additional wire to connect point b to point c. Notice that bulb 1 goes out (or becomes much dimmer) while bulb 2 remains fully lit (or becomes brighter).

7. Predict what will happen if the additional wire is used to connect other points on the circuit. Make your prediction in terms of what will happen to each of the bulbs. Will bulb 1 remain lit or go out? Will bulb 2 remain lit or go out?

Important Note: For purposes of this activity, “remaining lit” includes increased brightness, and “going out” includes significant dimming.

Remember to make predictions before making observations!

a. If point c is connected to point d, bulb 1 will __remain lit __go out and bulb 2 will __remain lit __go out.

b. If point d is connected to point e, ____

c. If point e is connected to point f, ____

d. If point f is connected to point a, ____

e. If point a is connected to point c, ____

f. If point a is connected to point d, ____

g. If point a is connected to point e, ____

h. If point b is connected to point d, ____

i. If point b is connected to point e, ____

Step 8: Observe what happens if the additional wire is used to make each of the connections.

a. When point c is connected to point d, bulb 1 __remains lit __goes out and bulb 2 __remains lit __goes out.

b. When point d is connected to point e, ____________________________________

c. When point e is connected to point f, ____________________________________

d. When point f is connected to point a, ____________________________________

e. When point a is connected to point c, ____________________________________

f. When point a is connected to point d, ____________________________________

g. When point a is connected to point e, ____________________________________

h. When point b is connected to point d, ____________________________________

i. When point b is connected to point e, ____________________________________

Part C: Short-Circuited Parallel Circuit

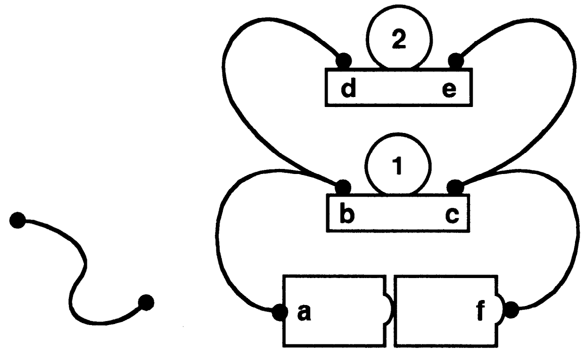

Figure 5. Parallel circuit and additional wire

Step 9: Arrange the parallel circuit shown in Figure 5. Notice that bulbs 1 and 2 light up. Notice there is an additional wire not yet in the circuit.

Step 10: Add the additional wire to the circuit, connecting point a to point b. Notice that both bulb 1 and bulb 2 remain fully lit.

Step 11: Now use the additional wire to connect point b to point c. Notice that bulb 1 goes out (or becomes much dimmer) while bulb 2 remains fully lit (or becomes brighter).

8. Predict what will happen if the additional wire is used to connect other points on the circuit. Make your prediction in terms of what will happen to each of the bulbs. Will bulb 1 remain lit or go out? Will bulb 2 remain lit or go out? **For purposes of this activity, "remaining lit" includes increased brightness, and "going out" includes significant dimming.** Remember to make predictions before making observations!

   a. If point c is connected to point d, bulb 1 will __remain lit __go out and bulb 2 will __remain lit __go out.

   b. If point d is connected to point e, ______________________________

   c. If point e is connected to point f, ______________________________

   d. If point f is connected to point a, ______________________________

   e. If point a is connected to point c, ______________________________

   f. If point a is connected to point d, ______________________________

   g. If point a is connected to point e, ______________________________

   h. If point b is connected to point d, ______________________________

   i. If point b is connected to point e, ______________________________

Step 12: Observe what happens if the additional wire is used to make each of the connections.

a. When point c is connected to point d, bulb 1 __remains lit __goes out and bulb 2 __remains lit __goes out.

b. When point d is connected to point e, ____

c. When point e is connected to point f, ____

d. When point f is connected to point a, ____

e. When point a is connected to point c, ____

f. When point a is connected to point d, ____

g. When point a is connected to point e, ____

h. When point b is connected to point d, ____

i. When point b is connected to point e, ____

Summing Up

1. What do open circuits and short circuits have in common?

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2. How are open circuits and short circuits different?

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3. Examine the cases in parts B and C when both bulbs went out. Is there anything that *all* those cases have in common?

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