36 Electric Current
Getting Wired

Purpose

To build a model to illustrate electric current.

Required Equipment and Supplies

4 D-cells (1.5 volt)
D-cell battery holder
3 alligator clip leads
2 #14 light bulbs (round)
2 light bulb sockets
magnetic compass

Note: It's important to use a voltage source between 3.6 and 4.5 volts (3 D-cells) for the specified bulbs. A greater voltage is likely to burn out the bulbs—a smaller voltage is not sufficient to light them.

Discussion

While we can see a raft gliding along the Mississippi or observe cars moving in traffic, nobody can *see* electric current flow. Even in the case of lightning, we are seeing the flash of the hot glowing gases produced by the electric current—not the current itself. However, we can infer the presence of electric current using light bulbs and magnetic compasses in much the same way that a flag indicates the presence of wind. In this activity, you will build a *model* to study electric current.

Part A: What is Required for a Bulb to Light?

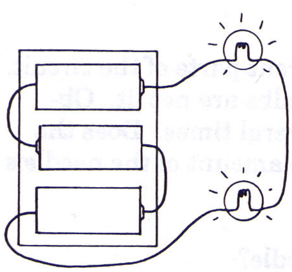

Figure 36.1

Step 1. Using a battery holder, three D-cells, three wires (or leads), two sockets, and two round bulbs, assemble a closed circuit as shown in Figure 36.1. The bulbs should light.

Step 2. Open the circuit by disconnecting a lead from one end of the battery. What happens?

1. Predict what will happen if the circuit is opened elsewhere in the circuit.

Prediction:

Try it and see, making sure there is only one break in the circuit at a time.

Results:

2. Did the location of the break in the circuit affect the results?

Step 3. What happens if one of the bulbs is unscrewed from the socket. Must the bulb be completely out of its socket to go out? When one bulb is unscrewed, do both bulbs go out?

Step 4. Screw the bulb back into its socket and then unscrew the other bulb. What happens?

3. Is it possible to light the bulbs when the battery is not in the circuit?

Step 5. Try to make the bulbs light by contact with only one wire in the circuit. Can they be lit? Briefly jot down what is required for a bulb to be lit.

Part B: What is Happening in the Wires?

Step 6. With the circuit arranged as in Step 1, turn the bulbs on and off by connecting and disconnecting one of the wires. Do you observe anything that indicates something is *moving* around the circuit? For example, does one bulb light before the other? Does one bulb go out before the other? Is one bulb brighter than the other?

4. Is there any visual evidence that something is moving around the circuit when the bulbs are lit?

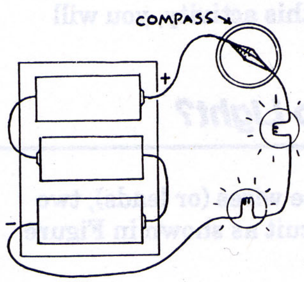

Figure 36.2

Step 7. Place a magnetic compass on the table near the circuit with the needle pointing to the "N." With the bulbs unlit, place one of the wires on top of the compass parallel to the needle as in Figure 36.2. Connect and disconnect a lead in the circuit several times while you observe the compass needle. What happens to the needle when the bulb lights? What happens to the needle when the bulbs go out?

Step 8. Place the compass beneath the wire in different parts of the circuit. Be sure the needle is parallel to the wire when the bulbs are not lit. Observe the needle as you open and close the circuit several times. Does the needle deflect in the same direction as before? Is the amount of the needle's deflection the same as before?

5. Must the bulbs be lit to deflect the compass needle?

6. What evidence supports the notion that something is happening in the wires while the bulbs are energized?

7. What evidence supports the notion that whatever is happening occurs uniformly in all parts of the circuit?

Part C: Is There Directionality to What is Happening in the Circuit?

Step 9. Arrange the circuit as in Figure 36.1 in Part A. Place one of the wires on top of the compass parallel to the needle. Open and close the circuit while you carefully observe the needle. Does the needle deflect clockwise or counterclockwise?

Step 10. Reverse the leads from the battery without altering the circuit and compass. Do this by simply exchanging the lead connected to the positive terminal of the battery with the lead connected to the negative terminal. Open and close the circuit while you watch the compass needle. Does the needle deflect? Is the deflection clockwise or counterclockwise? Is the direction of the deflection the same before the leads to the battery were reversed? Is the amount of the needle's deflection the same as before?

8. Suppose something is *flowing* in the wires. Do you think the *direction* the needle is deflected is caused by the *amount of the flow* or the *direction of the flow*?

Step 11. Remove one of the D-cells from the battery holder so that the battery holder has only two cells instead of three. Carefully observe deflection of the needle and repeat Steps 9 and 10.

9. How do the size and direction of the compass needle's deflections compare to those with 3 cells?

Step 12. Install two D-cells in the battery holder so that it has four D-cells. Carefully observe deflection of the needle as you repeat Steps 9 and 10.

10. How do the deflections of the compass needle compare with those when two and three D-cells were used? Do you think the *size* of the needle's deflection is caused by *amount of the flow* or the *direction of the flow*?

Analysis

11. Hypothesize what is happening in the circuit when bulbs are lit compared to when they are not.

12. Hypothesize what is happening in the circuit when the direction of the compass deflection reverses.

13. Hypothesize what is happening in the wires when the amount of the needle's deflection increases or decreases.

14. What do you think the battery does?