93 Ohm Sweet Ohm

Purpose

To investigate how current varies with voltage and resistance

Required Equipment/Supplies

nichrome wire apparatus with bulb
4 1.5-volt batteries
or
2 Genecon hand-crank generators

Discussion

Normally, it is desirable for wires in an electric circuit to stay cool. Red-hot wires can melt and cause short circuits. There are notable exceptions, however. Nichrome wire is a high-resistance wire capable of glowing red-hot without melting. It is commonly used as the heating element in toasters, ovens, stoves, hair dryers, and so forth. In this experiment, nichrome wire is used as a variable resistor. Doubling the length of a piece of wire doubles the resistance; tripling the length triples the resistance, and so on.

Tungsten wire is capable of glowing white-hot and is used as filaments in lightbulbs. Light and heat are generated as the current heats the high-resistance tungsten filament. The hotter the filament, the brighter the bulb. For the same voltage, a bright bulb (such as a 100-watt bulb) has a *lower* resistance than a dimmer bulb (such as a 25-watt bulb). Just as water flows with more difficulty through a thinner pipe, electrical resistance is greater for a thinner wire. Manufacturers make bulbs of different wattages by varying the thickness of the filaments, so we find that a 100-W bulb has a lower resistance and a thicker filament than a 25-W bulb.

In this lab, the brightness of the bulb will be used as a current indicator. A bright glow indicates a large current is flowing through the bulb; a dim glow means a small current is flowing.

Procedure

Assemble the battery with four D-cells.

Step 1: Connect four D-cell batteries in series, so that the positive terminal is connected to the negative terminal in a battery holder as shown in Figure A. This arrangement, with Terminal #1 as ground, will provide you with a variable voltage supply as indicated in Table A.

Data Table A

Terminal Numbers	Voltage (V)
1–2	1.5
1–3	3.0
1–4	4.5
1–5	6.0

Assemble the circuit and draw a circuit diagram.

Step 2: Assemble the circuit as shown in Figure B. Label one binding post of the nichrome wire "A" and the other "B." Attach the ground lead (#1) of the voltage supply to one side of a knife switch. Connect the other side of the switch to binding Post A on the thickest nichrome wire. Connect the 3-volt lead (#3) from the voltage supply to a clip lead of a test bulb. Attach the other clip lead of the test bulb to the other binding Post B on the nichrome wire.

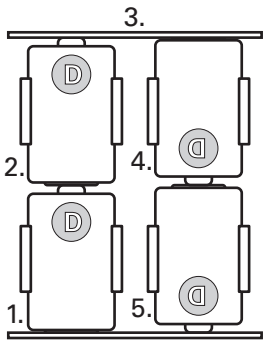

Fig. A

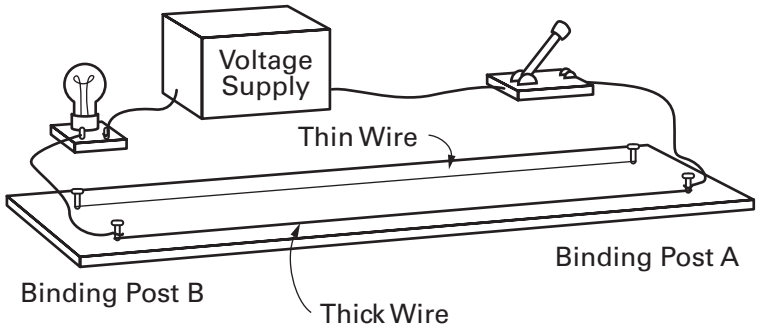

Fig. B

The voltage supply is now connected so that the current passes through two resistances: the bulb and the nichrome wire. You will vary the resistance in the circuit by moving the clip lead of the test bulb from binding Post B to binding Post A. Using the standard symbols for the circuit elements, draw a diagram that represents this series circuit.

Note: *Always apply power from battery packs by closing a switch and make your measurements quickly.* Leave the power on just long enough to make your measurements and then open the switch. *Leaving the power on in the circuit for long periods of time will drain your batteries and heat the wire, thereby changing its resistance.*

Observe the brightness of the bulb.

Step 3: After carefully checking all your connections, apply power to the circuit by closing the switch. Observe the intensity of the bulb as you move the test bulb lead from binding Post B toward A.

1. What happens to the brightness of the bulb as you move it from Binding Post B to A?

_____

_____

Repeat with thinner wire.

Step 4: Repeat using the thinner nichrome wire. Observe the relative brightness of the bulb as you move the bulb's lead closer to Binding Post A.

2. How does the brightness of the bulb with the thinner wire compare with the brightness of the bulb when connected to a thicker wire?

3. What effects do the thickness and length of the wire have on its resistance?

4. Does the current of the circuit increase or decrease as you move the lead closer to Binding Post B? As you move the lead from B to A, does the resistance of the circuit increase or decrease?

Step 5: Repeat Steps 1–2 using the 4.5 and 6-volt leads instead of the 3-volt leads.

5. How does the brightness of the test bulb compare for the two nichrome wires using 4.5 volts instead of 3 volts?

6. Combining your results from Questions 4 and 5, how does the current in the circuit depend upon voltage and resistance?

Going Further

Install ammeter in the circuit and measure current.

Step 6: Now insert an ammeter into the circuit as illustrated in Figure C. With the thicker piece of nichrome wire in the circuit, place the ammeter in series with the voltage supply between Terminal #1 of the voltage supply and the switch. The ammeter will read total current in the circuit. Measure the current in the circuit as you move the test bulb lead from B to A. Be sure to apply power *only* while making the measurements to prevent draining the batteries. Repeat using the thinner wire.

Note: *If you are not using a digital meter, you may have to reverse the polarity of the leads if the needle of the meter goes the wrong way (–) when power is applied.*

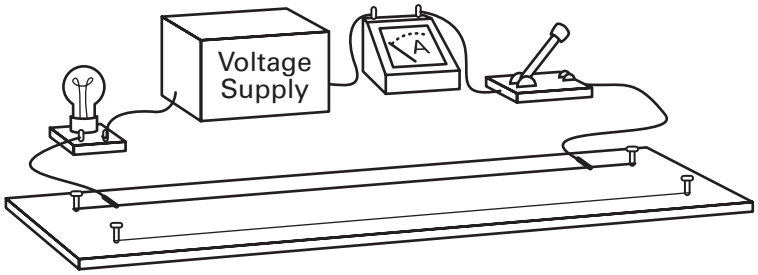

Fig. C

7. Do your results show a decrease in current as the resistance (or length of the wire) is increased?

8. Do your results show an increase in current as the voltage is increased?

9. How do the currents in the thicker and thinner wires compare when the same voltage is applied to the same lengths of wire?