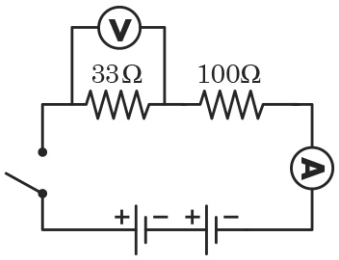
Investigation 17E: Electrical Power

Essential questions: How is power related to energy?
What determines the power rating of a device?

Electrical devices are commonly rated in units of power, such as a 100-W light bulb or a 1200-W microwave. The electric company bills homes in units of energy. Why the difference? In this investigation you will build circuits containing two different resistors in series and parallel (representing two different electrical devices), and measure the power and energy output of each device for each circuit.

Part 1: Resistors in series



1. Open the experiment file **17E_ElectricalPower** and then power-on the Current and Voltage sensors and connect them to your software.
2. Construct the circuit shown. Connect the voltage sensor across the 33-Ω resistor.
3. Begin recording data and close the switch. Continue recording data until the energy has reached 1 joule.
4. Repeat the experiment for the 100-Ω resistor.

Questions

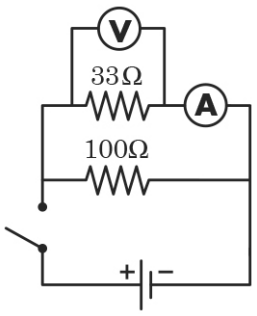
a. What happens to the power output for each resistor when the switch is closed? The energy measurement?

b. Which resistor recorded a higher power output? Why?

c. Which resistor consumed 1 joule of energy the fastest? How is this related to the power output?

d. Fit a line to each energy versus time run. How does the value of the slope compare to the power output? What does the slope represent?

Part 2: Resistors in parallel



1. Construct a circuit using the same components as Part 1, but wire the resistors in parallel. Place the current sensor in series with the 33-Ω resistor and connect the voltage sensor across the 33-Ω resistor.
2. Begin recording data and close the switch. Continue recording data until the energy has reached 1 joule.
3. Repeat the experiment for the 100-Ω resistor.

Questions

a. Does each resistor have the same power output as Part 1? Why or why not?

b. Which resistor has the higher power output? Is this the same as the results in Part 1? Why or why not?

c. Do the resistors consume energy faster in series or in parallel? Why?

d. Does the power output of a device depend on the properties of the device, how it is wired in the circuit, or both? Explain.

Applying new knowledge

1. Define electrical power and its unit.

2. How much current flows through an incandescent light bulb that draws 100 W of power from a 120-V outlet?

3. How much current flows through a 23-W compact fluorescent light bulb plugged into the same outlet?

4. If you double the current through a circuit, how does the electrical power change? What if you double the voltage instead?

5. A student measures a current of 0.60 amps through a 15-Ω resistor when a voltage of 9 V is applied to it.
   a. How much power is dissipated by the resistor?

   b. Into what form of energy is it likely converted?

   c. The resistor is rated at a maximum of 5 W. Does the power produced exceed this rating?

   d. What do you think happens to resistors if their power rating is exceeded?

6. Two 30-Ω resistors are connected in series to a 120-volt outlet.
   a. How much current flows through the circuit?

   b. What is the power output of this circuit?

7. Two 30-Ω resistors are connected in parallel to a 120-volt outlet.
   a. How much current flows through the circuit?

   b. What is the power output of this circuit?

8. Electrical power and the home.
   a. What is the typical unit of electricity usage that electrical power companies use to charge their customers?

   b. What is the physical quantity represented by this unit?

9. How many kilowatt-hours are consumed by a 100-W incandescent bulb if it is left on for an entire 24-hour day?