Some materials can become superconductors.

Some metals and compounds have zero resistance when their temperature falls below a *critical temperature*. These types of materials are called *superconductors*. Metals such as niobium, tin, and mercury and some metal compounds containing barium, copper, and oxygen become superconductors below their respective critical temperatures. The critical temperature depends on the material and ranges from less than –272 °C (–458 °F) to as high as –123 °C (–189 °F). The search continues for a material that is superconducting at room temperature.

Once a current is established in a superconductor, the current continues even if the applied voltage is removed. In fact, steady currents in superconducting loops have been observed to continue for many years without any signs of stopping. This feature makes such materials useful for a wide variety of applications.

One useful application of these materials is in superconducting magnets. These magnets are strong enough to levitate commuter trains, such as the one shown in **Figure 6,** above the tracks. As a result, the friction that would exist between the tracks and a normal train is eliminated. These magnets are also being studied for storing energy.



Figure 6 This train uses superconducting magnets to float above the tracks.

Section 2 Review

KEY IDEAS

1. **Describe** the motion of charges from one terminal of a battery to the other through a flashlight.
2. **Identify** which of the following could produce a current:
   - **a.** a wire connected across a battery's terminals
   - **b.** two electrodes in a solution of positive and negative ions
   - **c.** a salt crystal whose ions cannot move
   - **d.** a sugar-water mixture

CRITICAL THINKING

3. **Making Predictions** Predict which way a positive charge will move between two positions of different electrical potential energy, one high and one low.
   - **a.** from low to high
   - **b.** from high to low
   - **c.** back and forth between high and low
4. **Identifying Variables** What quantities are needed to calculate an object's resistance?
5. **Classifying** Classify the following materials as conductors or insulators: wood, paper clip, glass, air, paper, plastic, steel nail, and rubber.
6. **Inferring Conclusions** Recent discoveries have led some scientists to hope that a material will be found that is superconducting at room temperature. Why would such a material be useful?

Math Skills

7. If the current in a certain resistor is 6.2 A and the voltage across the resistor is 110 V, what is the resistance of the resistor?
8. If the voltage across a flashlight bulb is 3 V and the bulb's resistance is 6 Ω, what is the current through the bulb?

Close

Reteaching Key Ideas

Building on an Analogy Review the analogy between electrical potential energy and gravitational potential energy with students. Ask students how the analogy can be extended to describe current and resistance. (Sample answer: The rate at which balls roll down a hill is similar to a current. Placing objects such as rocks on the side of the hill to prevent balls from rolling downhill as quickly is similar to increasing resistance.)

LS **Logical**

Formative Assessment

Which of the following arrangements would have the highest electrical potential energy?

A. A large positive charge close to a large negative charge (Incorrect. A positive charge near a negative charge will have a low electrical potential energy.)

B. A large positive charge close to a small negative charge (Incorrect. A positive charge near a negative charge will have a low electrical potential energy.)

C. A large positive charge far away from small positive charge (Incorrect. A positive charge far away from another positive charge will have a low electrical potential energy.)

D. A large positive charge close to a large positive charge (Correct. A positive charge near another positive charge will have a high electrical potential energy.)

Answers to Section Review

1. Electrons move away from the negative terminal of the battery and travel through the filament in the light bulb. They heat the filament, causing it to give off light. The electrons then travel toward the positive terminal of the battery.
2. a, b
3. b
4. To calculate resistance, you need to know the voltage across the object and the current.
5. wood—insulator
   paper clip—conductor
   glass—insulator
   air—insulator
   paper—insulator
   plastic—insulator
   steel nail—conductor
   rubber—insulator
6. Such a material would enable people to use devices that rely on extremely efficient conductors of electricity (such as Maglev trains) without having to cool the conducting material to extremely cold temperatures.
7. $R = V/I = 110\ \text{V}/6.2\ \text{A} = 18\ \Omega$
8. $I = V/R = 3\ \text{V}/6\ \Omega = 0.5\ \text{A}$