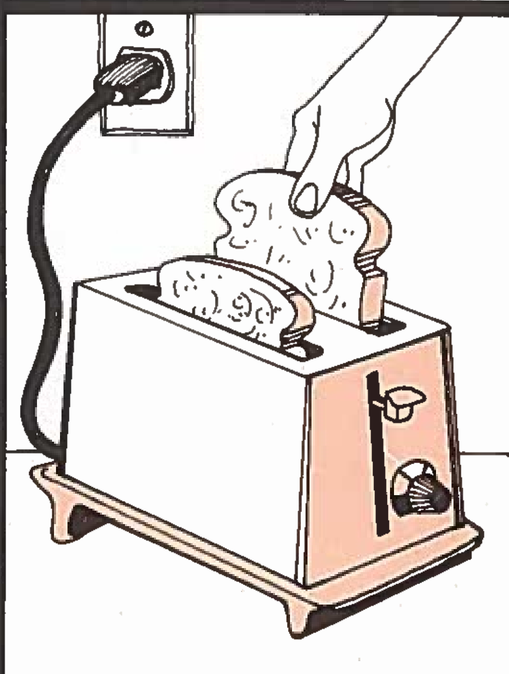
WHAT IS ELECTRICAL RESISTANCE?

5



resist: to work against

nichrome: a metal that resists electricity very much

molecule: two or more atoms linked up

AIM 5 | What is electrical resistance?

Imagine that you are walking against a strong wind. It isn't easy to walk. The wind is slowing you down. It is trying to stop you. We say the wind *resists* your movement.

Everything that moves meets some kind of *resistance*. Even electricity meets resistance.

Electric wire resists the flow of electrons. It tries to stop the electrons. The resistance makes the atoms and molecules rub together. This rubbing, or friction, builds heat. The greater the resistance, the greater the heat.

Electrical resistance can be slight—or very great—or in-between. Resistance depends mainly on three things. They are: *wire length*, *wire thickness*, and *the kind of metal* the wire is made of.

LENGTH OF WIRE Long wires resist electricity more than short wires do. The longer the wire, the more resistance.

THICKNESS OF WIRE Thin wires resist electricity more than thick wires do. The thinner the wire, the greater the resistance.

KIND OF METAL Some metals resist electricity more than others. Silver resists electricity the least. Copper resists electricity less than most metals. Metals that offer little resistance are good for electrical wiring. Most electrical wiring is made of copper.

Nichrome [NIE krome] is made of nickel and chromium. Nichrome offers great resistance to electricity. Metals that offer great resistance are good for producing heat. They can be used in toasters and electric irons.

RESISTANCE AND WIRE THICKNESS

Two wires A and B are shown below. They are the same length.

How are they different? ______________________________

____

A

B

Now fill in the blanks below using the letters A and B.

1. Electrons have *more* room to move along wire ________.
2. Electrons have *less* room to move along wire ________.
3. Electrons rub *more* along wire ________.
4. Electrons rub *less* along wire ________.
5. Which wire resists the electrons *more?* ________
6. Which wire resists the electrons *less?* ________
7. There is *more* friction along wire ____________.
8. There is *less* friction along wire ________.
9. Which wire stays *cooler?* ________
10. Which wire becomes *warmer?* ________

Conclusion: Thin wire resists electricity ____________ than thick wire.
(more, less)

RESISTANCE AND WIRE LENGTH

Two wires C and D are shown below. They are both the same thickness.

How are they different? ______________________________

____

Now fill in the blanks below, using the letters C and D.

1. Electrons move *farther* along wire __________.
2. Electrons move a *shorter distance* along wire __________.
3. Electrons rub *more* along wire __________.
4. Electrons rub *less* along wire __________.
5. Which wire resists the electrons *more?* __________
6. Which wire resists the electrons *less?* __________
7. There is *more* friction along wire __________.
8. There is *less* friction along wire __________.
9. Which wire stays *cooler?* __________
10. Which wire becomes *warmer?* __________

CONCLUSION:

Long wire resists electricity ______________ (more, less) than short wire.

CHOOSE ONE

Choose the correct word or term for each statement. Write your choice in the space.

1. To "resist" means to ______________.
   help, try to stop

2. Electrical resistance is caused by ______________.
   friction, switches

3. Friction comes from ______________.
   wires, rubbing

4. Friction produces ______________.
   electrons, heat

5. More friction means ______________ heat.
   more, less

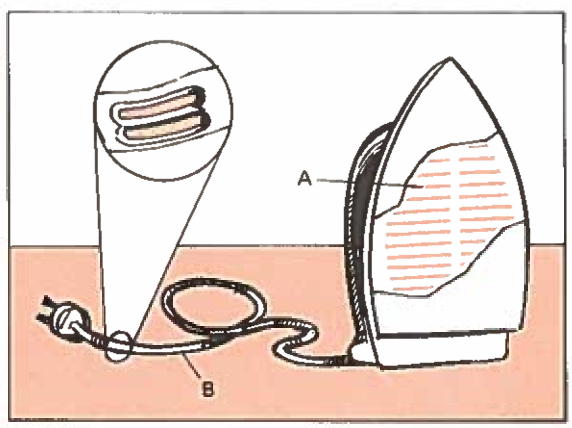
6. Less friction means ______________ heat.
   more, less

7. Long wire resists electricity ______________ than short wire.
   more, less

8. Thick wire resists electricity ______________ than thin wire.
   more, less

9. Nichrome is a ______________ resistance wire.
   high, low

10. Copper is a ______________ resistance wire.
    high, low



NAME THE WIRE

1. Copper wire is at ______________
   A, B

2. Nichrome wire is at ______________
   A, B

3. Name the *high* resistance wire. ______________

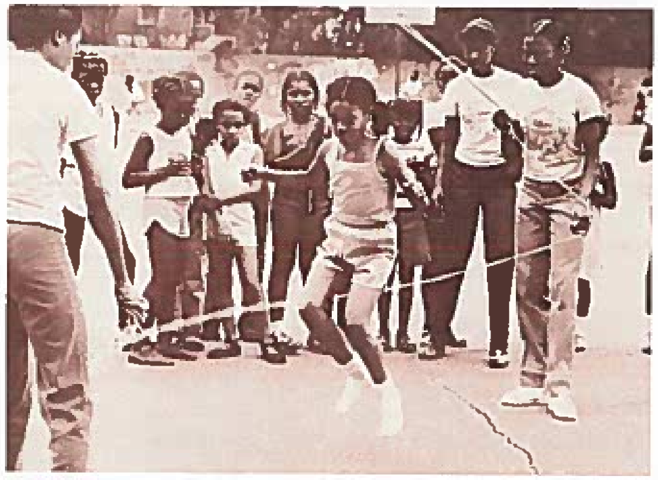
4. Name the *low* resistance wire. ______________

5. Which one gets *very* hot? ______________

6. Which one gets *less* hot? ______________

KEEPING UP WITH SCIENCE

ELECTRICITY WITH NO RESISTANCE



In 1911, Dutch physicist H.K. Onnes performed an experiment. He cooled mercury to 452 degrees below zero on the Fahrenheit scale (−268.88°C). That's nearly the coldest temperature possible. Onnes then sent an electric current through the supercooled mercury. He discovered that the mercury had lost all its resistance to electrical current. Since that time, scientists have tried to find out why this happens.

We know that all atoms vibrate. We also know that removing heat slows down the vibrations. Physicists have discovered that at extremely low temperatures the vibration speed of supercooled mercury atoms is timed perfectly with passing waves of electrons. Whenever a wave of electrons (electricity) passes a group of slowed-down, supercooled atoms, the vibrating atoms move *away* from the electrons. In other words, the atoms do not get in the way of the electrons. (It is like jumping rope. The feet miss the rope—the electricity misses the atoms.) When this happens, electrical resistance disappears.

The ability of certain ultracold substances to conduct electricity without resistance is called *superconductivity.* Until recently, superconductivity was only a scientific curiosity. Scientists believed this property had great potential. But they were unable to find ways of putting it to use until recently.

The main problem was to keep the object extremely cold. This is now possible because helium gas becomes a liquid when heat is removed from it. It condenses into a liquid at −268.88°C; it does not freeze (become a solid). A constant flow of liquid helium maintains the supercold temperature. Other problems have also been solved. Superconductivity is nearly ready to serve society. But how?

Superconductivity can produce more electrical power with much less fuel. For this reason it can save energy and a great deal of money. A generator with a supercold rotor can produce *twice* as much electricity as a standard generator *twice* its size.

The first superconducting generator in the United States is expected to be used by 1986. By the early part of the next century, this new breed of generator will probably produce most of our electricity.