9.6

Insulators and Conductors

Insulators

We often wear several different substances, such as wool and nylon, at the same time. The fabrics rub against each other and continually become charged with static electricity. The result can be very irritating, especially during winter, because the different pieces of clothing tend to stick to each other. The static charge remains in the places where the wool and nylon rub together because they are **electrical insulators**.

An electrical insulator is a substance in which electrons cannot move freely from atom to atom. If some atoms of an insulator become negatively charged with extra electrons, these electrons remain on the same atoms until removed by a substance that exerts a stronger force on the electrons. An insulator that has positively charged atoms on its surface behaves in a similar manner. This explains the continuous buildup of static charge on furniture and glass during cleaning. Wooden furniture and glass are both electrical insulators. When you polish furniture, the electric charges remain on the surfaces and attract uncharged dust particles.

Very large amounts of charge can still build up on the surface of an insulator. Review the electrostatic series on page 275. The amount of charge that builds up depends on the relative ability of the two substances to hold on to their electrons, and how much rubbing action occurs. Paint and wax are both insulators. The surface of a car can often build up very large amounts of charge due to the air rushing over it. Most people have experienced a static shock from a car when stepping out of it after a journey.

However, even though some insulators do cause static electricity problems, they can also be very useful (**Figure 1**). Because electrons cannot be conducted *through* electrical insulators, these materials can protect us from electric shocks. The two wires carrying the electric

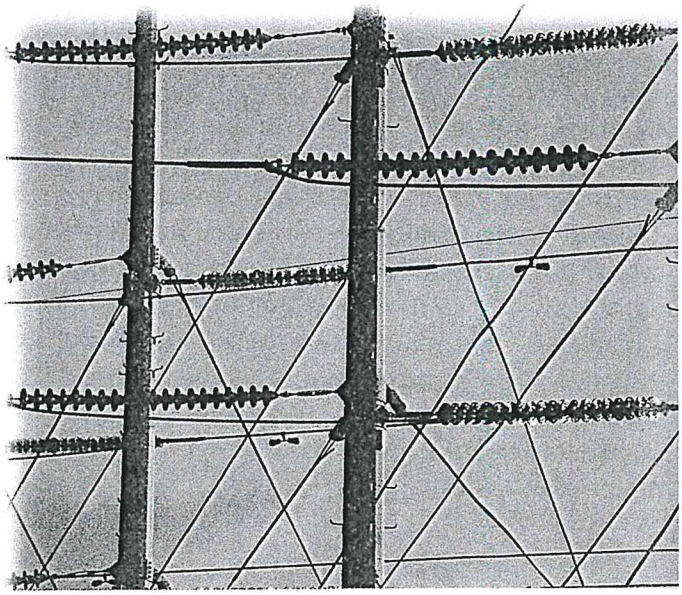

Figure 1

The long ceramic insulators isolate the high voltage transmission line from the metal support towers.

Table 1 **Common Conductors and Insulators**

Good Conductors	Fair Conductors	Good Insulators (Nonconductors)
silver	carbon	oil
copper	nichrome	fur
gold	human body	silk
aluminum	moist human skin	wool
magnesium	acid solutions	rubber
tungsten	salt water	porcelain, glass
nickel	Earth	plastic
mercury	water vapour (in air)	wood
platinum		paper
iron		wax
selenium (in the light)		ebonite
		selenium (in the dark)

current to an electric kettle would be very dangerous if they were not covered with a plastic or rubber insulating substance. Insulators cover many household tools and appliances. Electrical cords, plugs, wall sockets, and switches are actually metal conductors covered by an insulating substance.

Conductors

It doesn't matter how hard you polish a metal tap in the kitchen or bathroom, it never builds up a static charge because metals are **electrical conductors**. A conductor is a substance in which electrons can move freely from one atom to another. If a conductor becomes negatively charged with extra electrons, they move freely (are conducted) along the conductor. When taps are charged negatively by friction, the extra electrons repel one another and are conducted away from the taps along metal water pipes to the main water supply pipe, where they transfer into the ground. Because the electric charge is conducted away as soon as it is produced, the taps remain uncharged.

Table 1 lists common conductors and insulators.

Static Electricity and Winter

The reason that problems with static electricity are much worse in winter than during other times of the year is that the cold air is so much drier and contains fewer water molecules than it does in other seasons. Dry air is an insulator and does not easily pick up charges from our body as the air molecules constantly collide against us. So, in the winter, any static charge that builds up on our clothes or on painted or polished surfaces tends to stay there. At other times of the year, the air is warmer and contains huge numbers of water molecules. Water molecules tend to pick up and transfer electric charges easily. When the air is moist, the molecules of water vapour in the air are constantly striking us all over our bodies, and these water molecules redistribute the static charges produced by friction as soon as they occur.

Challenge

What materials would you consider using when building the case for your electric circuit board to minimize the effect of static electricity for the user?

Understanding Concepts

1. Explain the difference between a conductor and an insulator, in terms of the transfer of electrons. Use diagrams to illustrate your explanation.
2. **(a)** Why does the amount of static charge continue to increase on a glass surface as you rub it?
   (b) What would eventually happen if you continued rubbing it?
3. If you charged the end of a plastic comb and then put the same kind of charge on one place on the surface of a round metal ball on an insulating stand, what would happen to the charge in each case? Explain why with the help of a diagram.
4. Why are problems with static electricity more common in winter than at other times of the year? How could any of these problems be reduced?

Making Connections

5. Look around your home, or in the family car, and identify examples where insulators and conductors are used on electrical equipment. Give reasons for their use.
6. List at least two reasons why you think plastic materials are used to cover the copper wires in electrical equipment.

Exploring

7. When people began using electricity in homes, copper wire was used. Then in the 1970s aluminum wire largely replaced copper. After a few years, aluminum was replaced by copper again. Why did each change occur? List the advantages and disadvantages of using each metal.