SECTION 4

Using the Properties of Matter

You can describe substances by the physical and chemical properties they have. You can even use those properties to distinguish one substance from another. But one of the most important uses of the properties of matter is in selecting materials for technological design.

READING WARM-UP

Objectives

- Describe the use of materials in technological design based on density or magnetism.
- Describe the use of materials in technological design based on electrical conductivity or malleability.
- Describe the use of materials in technological design based on solubility.

READING STRATEGY

Reading Organizer As you read this section, create an outline of the section. Use the headings from the section in your outline.

Density

Think of a child holding the string of a helium-filled balloon. Believe it or not, this is an example of how properties are used in technological design. Because helium's density is lower than the density of air, the balloon floats. Helium's density is a property that makes helium useful in blimps and in weather balloons.

Density and Fishing

If you have ever gone fishing, you probably made use of the densities of materials. To get the hook as deep as the fish are, you would use a lead sinker. The density of lead helps drag the hook and line underwater. To avoid the problem of the hook sinking all the way to the bottom and snagging on something, you could attach a float, such as the one in **Figure 1.**

The float has a density that is less than the density of water, so it will float at the water's surface. If a fish grabs the hook, the float is pulled under water. When you see the float dip into the water, you know that it is time to hold tightly to the fishing rod! The combination of the high density of lead and the low density of the float allows you to design a system that gives you a better chance of catching your dinner!

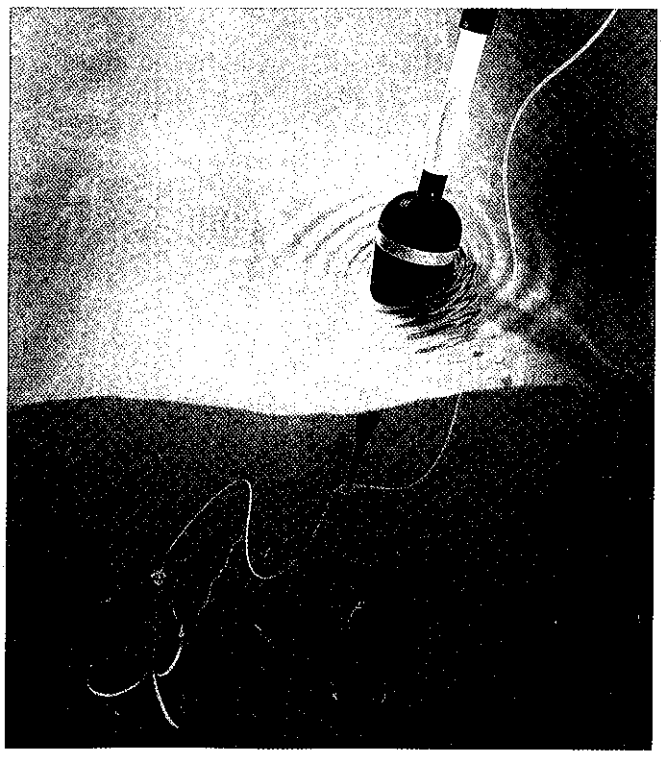
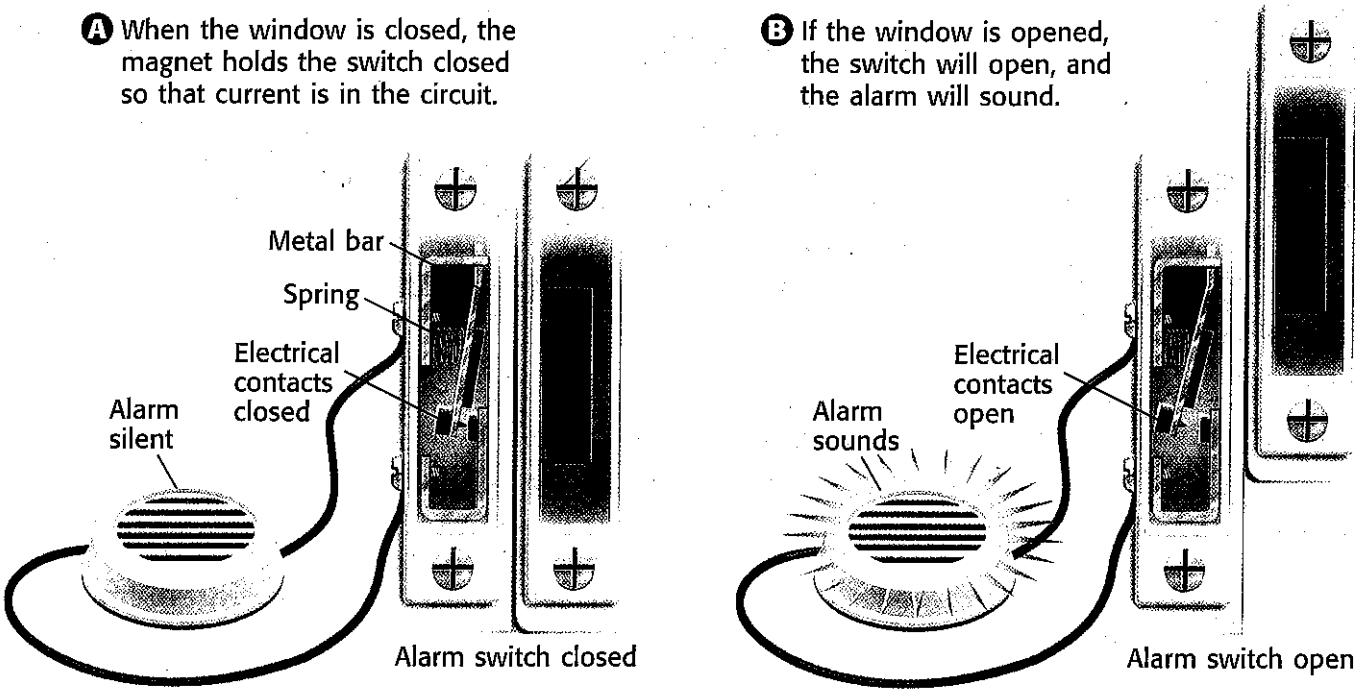


Figure 1 *The colorful float is less dense than water. It is used to keep the hook from sinking all the way to the bottom and snagging.*

Figure 2 Using Magnetism in an Alarm

A When the window is closed, the magnet holds the switch closed so that current is in the circuit.

B If the window is opened, the switch will open, and the alarm will sound.



Magnetism

You may think of magnets as devices used to attach papers or photos to a refrigerator door. But magnets are involved in many different devices. The property of magnetism is very important in technological design. For example, some hand tools, such as hammers and screwdrivers, are made from materials that have been magnetized. These tools can be a big help in tight spaces because they attract and hold onto the nail or screw while you work with it.

Magnetism and Alarms

The magnetic properties of materials are also very important in some alarm systems. The alarm shown in **Figure 2** uses the simple magnetic attraction between a piece of iron and a magnet to alert homeowners that a window or door has been opened. When the window is closed, the iron switch is attracted to the magnet. The switch completes an electric circuit, and electric charges flow through the system. When the window slides open, as shown in **Figure 2,** the magnet is no longer near enough to the iron to attract it strongly. The spring pulls the switch open, and the circuit is broken. When this happens, the alarm sounds.

Reading Check **Describe one way in which magnetism is used in a technological design.** (*See the Appendix for answers to Reading Checks.*)

Electrical Conductivity

Another property that is important in technological design is electrical conductivity. This property describes how well charges move through a material. Metals tend to have high electrical conductivities. So, metals are used when you want charges to move. If you do not want charges to move, you can use a material that has a low electrical conductivity, such as rubber or plastic. An electrical cord is made up of metal wires covered in rubber or plastic. Charges can move in the wires but charges cannot move through the rubber or plastic.

Conductivity and Coins

On January 27, 2000, the first Golden Dollars, like the one shown in **Figure 3,** were put into circulation. A law passed in 1997 called for a new dollar coin to be minted. The new coin was replacing a dollar coin that was minted in 1979 and 1980. The new coin had to be gold in color, so the metals used in the old silver-colored coin could not be used. The new coin had to be the same size as the old coin. That wasn't difficult. But in addition to size, vending machines use electrical conductivity to recognize coins. So, the new coin had to have the same conductivity as the previous coin. Otherwise, the machines would need to be adjusted to accept the new coins.

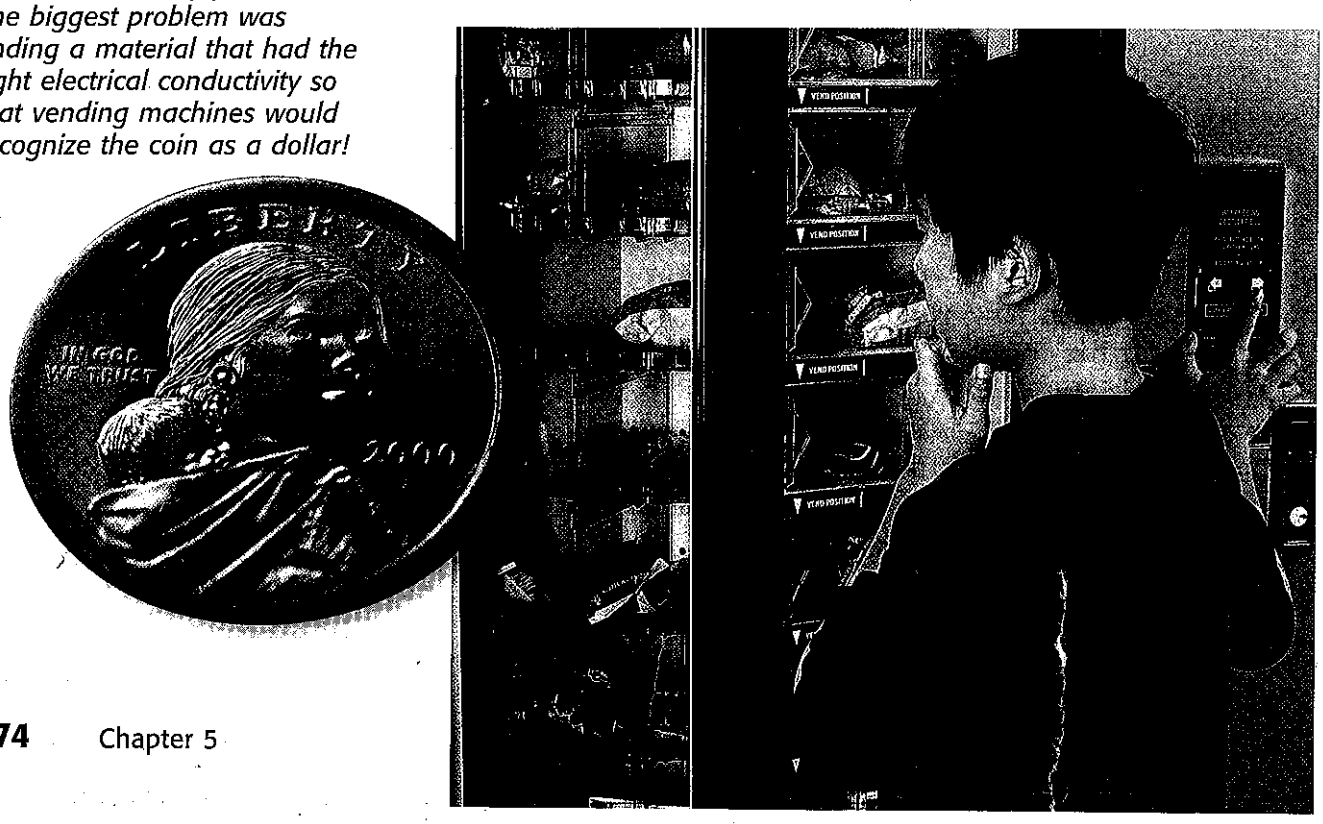
Just three months before minting of the coins was scheduled to begin, a mixture, or alloy, of copper, zinc, manganese, and nickel was developed that worked. Coins made by sandwiching a copper core between two layers of this alloy had the proper electrical conductivity. A new coin was born!

CONNECTION TO Social Studies

WRITING SKILL **Edison and the Light Bulb**

Thomas Alva Edison invented or made improvements to many devices. He conducted many experiments using different materials to find a material that had the right electrical conductivity to use in an incandescent light bulb. Research Edison's work on the light bulb. Make a poster that shows some of the materials Edison used in his research and which material finally worked.

Figure 3 *The technological design of the Golden Dollar had to overcome many problems. The biggest problem was finding a material that had the right electrical conductivity so that vending machines would recognize the coin as a dollar!*



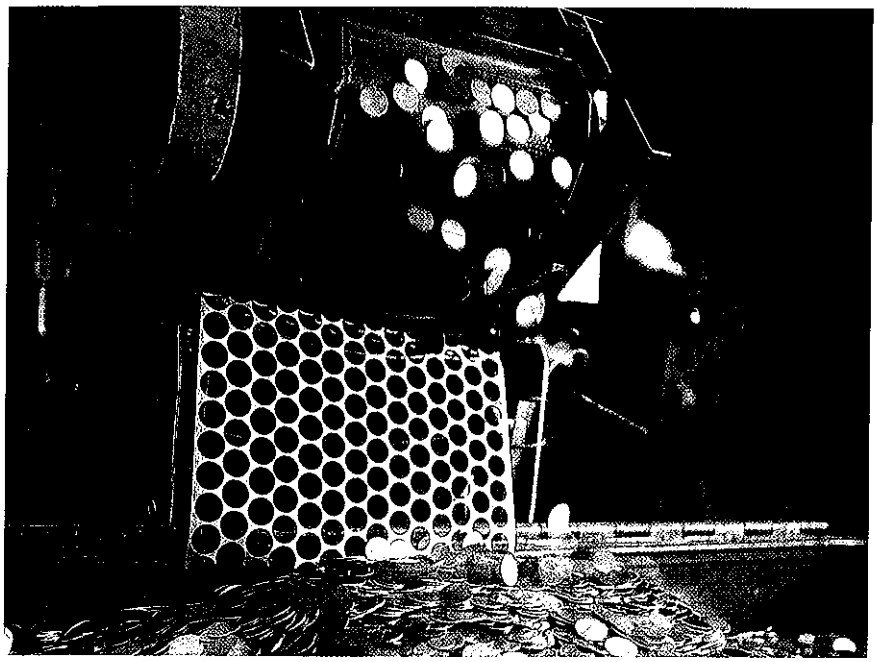


Figure 4 *These metal blanks will be made into coins. The metal must be malleable so that it can be squeezed to the correct thickness for the coins.*

Malleability

A material commonly used to demonstrate the property of malleability is aluminum. Aluminum is a material which is rolled out to make cans and foil. Aluminum foil is even available in various thicknesses. Another example of the use of malleability is in making coins.

Each coin must be the same thickness as all other coins of that type. To make the thickness uniform, the metal is squeezed between rollers and cut into blanks, like those shown in **Figure 4.** The materials chosen to be made into coins must have the proper malleability so that they can be squeezed without breaking.

Reading Check **Is wood a suitable material for use in a design that requires a material to be flattened into sheets? Explain your reasoning.**

Identifying Change

1. Get a **set of coins** from your teacher. Make a table to organize your observations of each coin in your set.
2. Examine each coin. Record your observations in your table.
3. Use a **balance** to determine the mass of each coin. Record the mass in your table.
4. What characteristics allow you to identify each coin?
5. Using only your sense of touch, try to identify each coin. Was identifying the coins difficult? Explain your answer.
6. Why is it important that coins are recognizable by touch as well as by sight?

Solubility

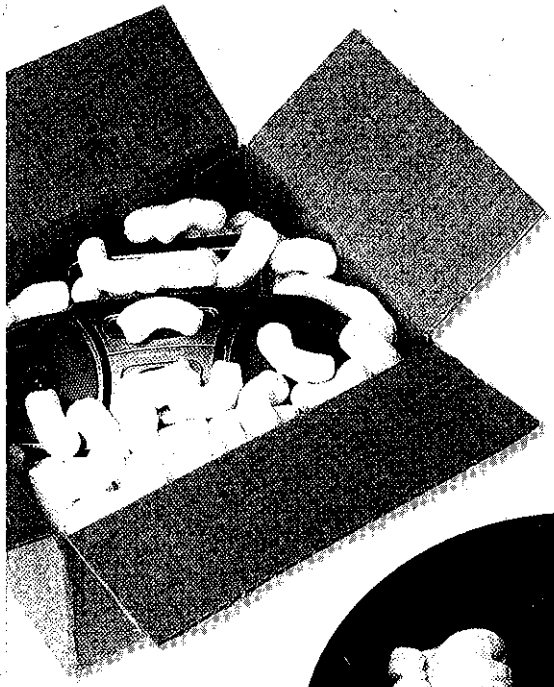
It is safe to say that you wouldn't want your coins to dissolve if they were to get wet. But are there times when you do want a material that can dissolve in water? As they develop new materials that have unique properties, scientists are finding creative ways to use solubility in technological design.

Starch-Based Packing Material

Imagine that the package shown in **Figure 5** was delivered to your home. After you take out the radio, what do you do with the box and the packing peanuts? You could reuse or recycle the cardboard box. But would you think to get rid of the packing peanuts by washing them down the drain?

For years, packing peanuts were made of a plastic foam. These peanuts would often be thrown into the trash and end up in landfills. Because the plastic did not break down, the peanuts would remain in the landfill for many years. An interesting problem in technological design was to develop a packing material that would break down easily and would not be harmful to the environment.

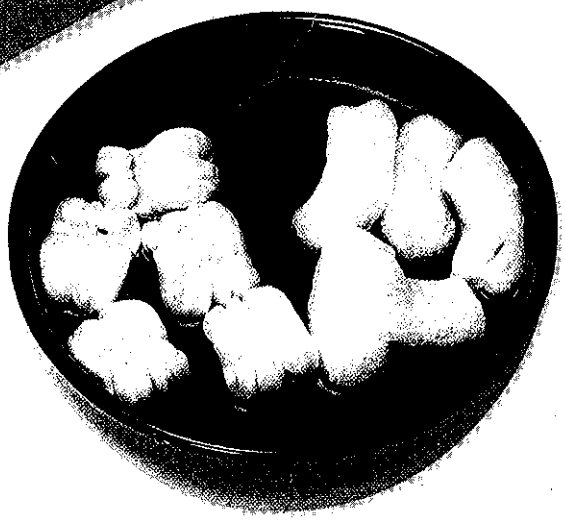
Figure 5 *The radio is protected by starch-based peanuts. In just a few minutes, these peanuts dissolve in a bowl of water. The plastic-foam peanuts do not.*

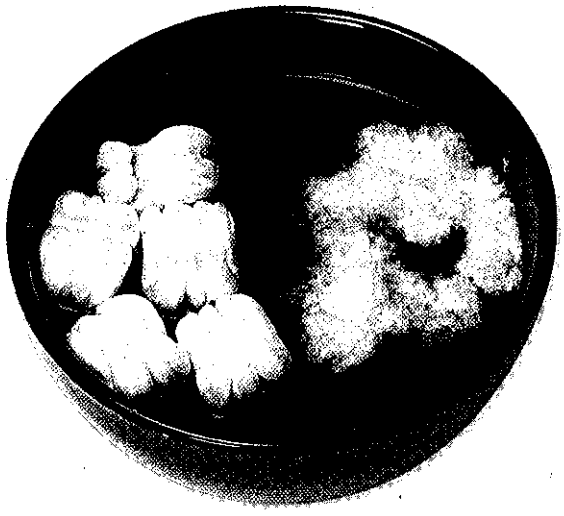


Benefits of Starch-Based Packing Material

Packing peanuts that are made from starch dissolve quickly in water, as shown in **Figure 5.** They do not need to be thrown away. They can even be composted. Because they break down quickly into natural materials, they do not fill up landfills. And they are made from plant material, such as corn, which is a renewable resource. The chemicals used to make plastic-foam peanuts are made from petroleum, which is a nonrenewable resource.

Reading Check **Why is solubility an important property in the design of packing peanuts?**





Water-Soluble Films

The strips shown in **Figure 6** are designed to kill germs and freshen breath as they dissolve. The film that is used must dissolve quickly to release the ingredients contained in the film. Films dissolve at different rates depending on their chemical makeup and thickness, on the water temperature, and on the volume of water. In industry, water-soluble films are used to package fertilizer, cleaners, and even foodstuffs. The films protect people from coming into contact with the material. The films also protect the environment by not leaving behind packaging waste that might have chemicals on it.

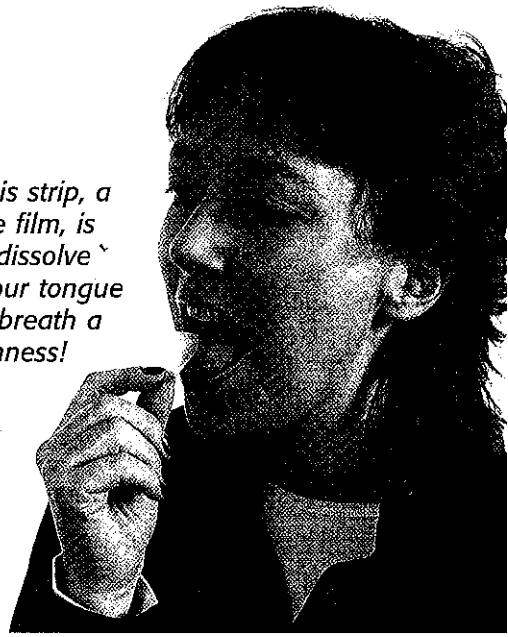


Figure 6 *This strip, a water-soluble film, is designed to dissolve quickly on your tongue to give your breath a burst of freshness!*

SECTION Review

Summary

- Properties of materials make them suitable for use in different technological designs.
- Designs that need things to float or sink might be based on density.
- Designs that need to hold things together might be based on magnetism.
- Designs of coins might be based on electrical conductivity and malleability.
- Designs that need things to dissolve or not to dissolve might be based on solubility.

Understanding Key Ideas

1. Flattening metal to make coins demonstrates which property?
   - **a.** electrical conductivity
   - **b.** density
   - **c.** solubility
   - **d.** malleability
2. Which property would be important to consider if you were designing a hot-air balloon?
   - **a.** density
   - **b.** electrical conductivity
   - **c.** malleability
   - **d.** magnetism
3. Describe how magnetism can be used in the design of earrings that look as though they are made for pierced ears.
4. Many data-storage devices, such as computer hard drives, record information magnetically. Explain why materials that are strongly magnetized would not be suitable in the construction of the hard drive's case.
5. Why is the metal copper a better choice than plastic for use in a lightning rod?

Critical Thinking

6. **Applying Concepts** A company wants to develop a new product that contains laundry detergent and softener in a single packet. The detergent should be released within the first 2 min of the wash cycle, and the softener should be released 5 min later. Describe the suitability of films for use in this design based on solubility.
7. **Applying Concepts** Describe the suitability of concrete in terms of its density and solubility for use in making a boat.