HEAT AND WORK

Hammer a nail into a block of wood. After several minutes, pry the nail loose from the block and touch the side of the nail. It feels warm to the touch, indicating that energy is being transferred from the nail to your hand. Work is done in pulling the nail out of the wood. The nail encounters friction with the wood, and most of the energy required to overcome this friction is transformed into internal energy. The increase in the internal energy of the nail raises the nail's temperature, and the temperature difference between the nail and your hand results in the transfer of energy to your hand as heat.

Friction is just one way of increasing a substance's internal energy. In the case of solids, internal energy can be increased by deforming their structure. Common examples of this deformation are stretching a rubber band or bending a piece of metal.

Total energy is conserved

When the concept of mechanical energy was introduced, you discovered that whenever friction between two objects exists, not all of the work done appears as mechanical energy. Similarly, when objects collide inelastically, not all of their initial kinetic energy remains as kinetic energy after the collision. Some of the energy is absorbed as internal energy by the objects. For this reason, in the case of the nail pulled from the wood, the nail (and if you could touch it, the wood inside the hole) feels warm. If changes in internal energy are taken into account along with changes in mechanical energy, the total energy is a universally conserved property. In other words, the sum of the changes in potential, kinetic, and internal energy is equal to zero.

CONSERVATION OF ENERGY

$$\Delta PE + \Delta KE + \Delta U = 0$$

the change in potential energy + the change in kinetic energy + the change in internal energy = 0

extension

Integrating Environmental Science

Visit go.hrw.com for the activity "Understanding the Conservation of Energy."

Keyword HF6HATX

Quick Lab

Work and Heat

MATERIALS LIST

- **1 large rubber band about 7–10 mm wide**

SAFETY

To avoid breaking the rubber band, do not stretch it more than a few inches. Do not point a stretched rubber band at another person.

Hold the rubber band between your thumbs. Touch the middle section of the rubber band to your lip and note how it feels. Rapidly stretch the rubber band and keep it stretched. Touch the middle section of the rubber band to your lip again. Notice whether the rubber band's temperature has changed. (You may have to repeat this procedure several times before you can clearly distinguish the temperature difference.)