FIGURE 19 Unlike ionic crystalline compounds, most metals are malleable. This property allows iron, for example, to be shaped into useful tools.

Most metals are also easy to form into desired shapes. Two important properties related to this characteristic are malleability and ductility. **Malleability** *is the ability of a substance to be hammered or beaten into thin sheets*. **Ductility** *is the ability of a substance to be drawn, pulled, or extruded through a small opening to produce a wire.* The malleability and ductility of metals are possible because metallic bonding is the same in all directions throughout the solid. When struck, one plane of atoms in a metal can slide past another without encountering resistance or breaking bonds. By contrast, recall from Section 3 that shifting the layers of an ionic crystal causes the bonds to break and the crystal to shatter.

Metallic Bond Strength

Metallic bond strength varies with the nuclear charge of the metal atoms and the number of electrons in the metal's electron sea. Both of these factors are reflected in a metal's *enthalpy of vaporization*. The amount of energy as heat required to vaporize the metal is a measure of the strength of the bonds that hold the metal together. The enthalpy of vaporization is defined as the amount of energy absorbed as heat when a specified amount of a substance vaporizes at constant pressure. Some enthalpies of vaporization for metals are given in **Table 4.**

TABLE 4 ***Enthalpies of Vaporization of Some Metals (kJ/mol)***

Period	Element		
Second	Li 147	Be 297	
Third	Na 97	Mg 128	Al 294
Fourth	K 77	Ca 155	Sc 333
Fifth	Rb 76	Sr 137	Y 365
Sixth	Cs 64	Ba 140	La 402

SECTION REVIEW

1. Describe the electron-sea model of metallic bonding.
2. What is the relationship between metallic bond strength and enthalpy of vaporization?
3. Explain why most metals are malleable and ductile but ionic crystals are not.

Critical Thinking

4. **ORGANIZING IDEAS** Explain why metals are good electrical conductors.