## SECTION REVIEW

1. Use the first law of thermodynamics to show that the internal energy of an isolated system is always conserved.

2. In the systems listed below, identify where energy is transferred as heat and work and where changes in internal energy occur. Is energy conserved in each case?
   - **a.** the steam in a steam engine consisting of a boiler, a firebox, a cylinder, a piston, and a flywheel
   - **b.** the drill bit of a power drill and a metal block into which a hole is being drilled

3. Express the first law of thermodynamics for the following processes:
   - **a.** isothermal
   - **b.** adiabatic
   - **c.** isovolumetric

4. A compressor for a jackhammer expands the air in the hammer's cylinder at a constant pressure of $8.6 \times 10^5$ Pa. The increase in the cylinder's volume is $4.05 \times 10^{-4}$ $m^3$. During the process, 9.5 J of energy is transferred out of the cylinder as heat.
   - **a.** What is the work done by the air?
   - **b.** What is the change in the air's internal energy?
   - **c.** What type of ideal thermodynamic process does this approximate?

5. A mixture of fuel and air is enclosed in an engine cylinder fitted with a piston. The gas pressure is maintained at $7.07 \times 10^5$ Pa as the piston moves slowly inward. If the gas volume decreases by $1.1 \times 10^{-4}$ $m^3$ and the internal energy of the gas increases by 62 J, how much energy is added to or removed from the system as heat?

6. Over several cycles, a refrigerator does $1.51 \times 10^4$ J of work on the refrigerant. The refrigerant in turn removes $7.55 \times 10^4$ J as heat from the air inside the refrigerator.
   - **a.** How much energy is transferred as heat to the outside air?
   - **b.** What is the net change in the internal energy of the refrigerant?
   - **c.** What is the amount of work done on the air inside the refrigerator?
   - **d.** What is the net change in the internal energy of the air inside the refrigerator?

7. If a weather balloon in flight gives up 15 J of energy as heat and the gas within it does 13 J of work on the outside air, by how much does its internal energy change?

8. **Critical Thinking** After reading the feature on the next page, explain why opening the refrigerator door on a hot day does not cause your kitchen to become cooler.