

## PRACTICE B

### The First Law of Thermodynamics

1. Heat is added to a system, and the system does 26 J of work. If the internal energy increases by 7 J, how much heat was added to the system?
2. The internal energy of the gas in a gasoline engine's cylinder decreases by 195 J. If 52.0 J of work is done by the gas, how much energy is transferred as heat? Is this energy added to or removed from the gas?
3. A 2.0 kg quantity of water is held at constant volume in a pressure cooker and heated by a range element. The system's internal energy increases by  $8.0 \times 10^3$  J. However, the pressure cooker is not well insulated, and as a result,  $2.0 \times 10^3$  J of energy is transferred to the surrounding air. How much energy is transferred from the range element to the pressure cooker as heat?
4. The internal energy of a gas decreases by 344 J. If the process is adiabatic, how much energy is transferred as heat? How much work is done on or by the gas?
5. A steam engine's boiler completely converts 155 kg of water to steam. This process involves the transfer of  $3.50 \times 10^8$  J as heat. If steam escaping through a safety valve does  $1.76 \times 10^8$  J of work expanding against the outside atmosphere, what is the net change in the internal energy of the water-steam system?

#### cyclic process

*a thermodynamic process in which a system returns to the same conditions under which it started*

### CYCLIC PROCESSES

A refrigerator performs mechanical work to create temperature differences between its closed interior and its environment (the air in the room). This process leads to the transfer of energy as heat. A heat engine does the opposite: it uses heat to do mechanical work. Both of these processes have something in common: they are examples of **cyclic processes**.

In a cyclic process, the system's properties at the end of the process are identical to the system's properties before the process took place. The final and initial values of internal energy are the same, and the change in internal energy is zero.

$$\Delta U_{net} = 0 \text{ and } Q_{net} = W_{net}$$

A cyclic process resembles an isothermal process in that all energy is transferred as work and heat. But now the process is repeated with no net change in the system's internal energy.