7. (II) In an engine, an almost ideal gas is compressed adiabatically to half its volume. In doing so, 1850 J of work is done on the gas. (*a*) How much heat flows into or out of the gas? (*b*) What is the change in internal energy of the gas? (*c*) Does its temperature rise or fall?

8. (II) An ideal gas expands at a constant total pressure of 3.0 atm from 400 mL to 660 mL. Heat then flows out of the gas at constant volume, and the pressure and temperature are allowed to drop until the temperature reaches its original value. Calculate (*a*) the total work done by the gas in the process, and (*b*) the total heat flow into the gas.

9. (II) One and one-half moles of an ideal monatomic gas expand adiabatically, performing 7500 J of work in the process. What is the change in temperature of the gas during this expansion?

10. (II) Consider the following two-step process. Heat is allowed to flow out of an ideal gas at constant volume so that its pressure drops from 2.2 atm to 1.4 atm. Then the gas expands at constant pressure, from a volume of 6.8 L to 9.3 L, where the temperature reaches its original value. See Fig. 15–22. Calculate (*a*) the total work done by the gas in the process, (*b*) the change in internal energy of the gas in the process, and (*c*) the total heat flow into or out of the gas.

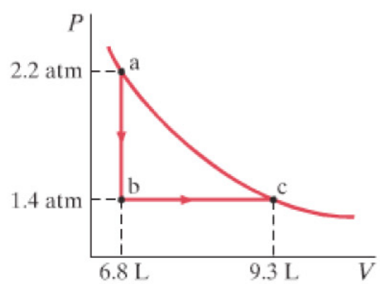

FIGURE 15–22 Problem 10.

11. (II) The *PV* diagram in Fig. 15–23 shows two possible states of a system containing 1.35 moles of a monatomic ideal gas. ($P_1 = P_2 = 455\ \text{N/m}^2$, $V_1 = 2.00\ \text{m}^3$, $V_2 = 8.00\ \text{m}^3$.) (*a*) Draw the process which depicts an isobaric expansion from state 1 to state 2, and label this process A. (*b*) Find the work done by the gas and the change in internal energy of the gas in process A. (*c*) Draw the two-step process which depicts an isothermal expansion from state 1 to the volume V_2, followed by an isovolumetric increase in temperature to state 2, and label this process B. (*d*) Find the change in internal energy of the gas for the two-step process B.

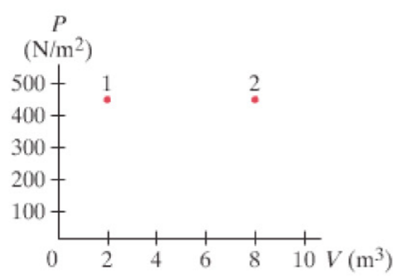

FIGURE 15–23 Problem 11.

12. (III) When a gas is taken from a to c along the curved path in Fig. 15–24, the work done by the gas is $W = -35\ \text{J}$ and the heat added to the gas is $Q = -63\ \text{J}$. Along path abc, the work done is $W = -48\ \text{J}$. (*a*) What is Q for path abc? (*b*) If $P_c = \frac{1}{2}P_b$, what is W for path cda? (*c*) What is Q for path cda? (*d*) What is $U_a - U_c$? (*e*) If $U_d - U_c = 5\ \text{J}$, what is Q for path da?

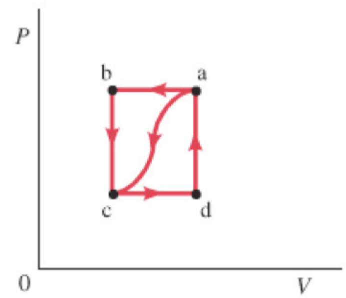

FIGURE 15–24 Problems 12 and 13.

13. (III) In the process of taking a gas from state a to state c along the curved path shown in Fig. 15–24, 80 J of heat leaves the system and 55 J of work is done *on* the system. (*a*) Determine the change in internal energy, $U_a - U_c$. (*b*) When the gas is taken along the path cda, the work done by the gas is $W = 38\ \text{J}$. How much heat Q is added to the gas in the process cda? (*c*) If $P_a = 2.5P_d$, how much work is done by the gas in the process abc? (*d*) What is Q for path abc? (*e*) If $U_a - U_b = 10\ \text{J}$, what is Q for the process bc? Here is a summary of what is given:

$$Q_{a\rightarrow c} = -80\ \text{J}$$
$$W_{a\rightarrow c} = -55\ \text{J}$$
$$W_{cda} = 38\ \text{J}$$
$$U_a - U_b = 10\ \text{J}$$
$$P_a = 2.5P_d.$$

* 15–3 Human Metabolism

* 14. (I) How much energy would the person of Example 15–8 transform if instead of working 11.0 h she took a noontime break and ran for 1.0 h?

* 15. (I) Calculate the average metabolic rate of a person who sleeps 8.0 h, sits at a desk 8.0 h, engages in light activity 4.0 h, watches television 2.0 h, plays tennis 1.5 h, and runs 0.5 h daily.

* 16. (II) A person decides to lose weight by sleeping one hour less per day, using the time for light activity. How much weight (or mass) can this person expect to lose in 1 year, assuming no change in food intake? Assume that 1 kg of fat stores about 40,000 kJ of energy.

15–5 Heat Engines

17. (I) A heat engine exhausts 8200 J of heat while performing 3200 J of useful work. What is the efficiency of this engine?

18. (I) A heat engine does 9200 J of work per cycle while absorbing 22.0 kcal of heat from a high-temperature reservoir. What is the efficiency of this engine?

19. (I) What is the maximum efficiency of a heat engine whose operating temperatures are 580°C and 380°C?