1. Calculate the heat necessary to increase the temperature of (a) 100. g of water and (b) 2.00 mol $H_2O(l)$ from 20. °C to 100. °C .
Note: $C_s(H_2O)$= 4.18 J K^{-1} g^{-1}

2. A calorimeter was calibrated by mixing two aqueous solutions, each of volume 0.100 L. The heat output of the reaction that took place was known to be 4.16 kJ, and the temperature of the calorimeter rose by 3.24 °C. Calculate the heat capacity of this calorimeter when it contains 0.200 L of water.

3. A metal nugget with a mass of 58.7 g is heated to 372.7 K, then placed in a cup calorimeter with 80.0 g of water whose temperature is 296.8 K. The final temperature of the metal, water, and calorimeter is 299.0 K. The calorimeter constant is 23.7 J/K. Calculate the specific heat capacity of the metal.

4. Suppose that 1.00 kJ of energy is transferred as heat to oxygen in a cylinder fitted with a piston; the external pressure is 2.00 atm. The oxygen expands from 1.00 L to 3.00 L against this constant pressure. Calculate *w* and Δ*U* for the entire process by treating the O_2 as an ideal gas.

5. In an endothermic reaction at constant pressure, 30. kJ of energy entered the system as heat. The products took up less volume than the reactants, and 40. kJ of energy entered the system as work as the outside atmosphere pressed down on it. What are the values of (a) Δ*H* and (b) Δ*U* for this process?

6. Calculate the final temperature and the change in enthalpy when 500. J of energy is transferred as heat to 0.900 mol $O_2(g)$ at 298 K and 1.00 atm at (a) constant pressure; (b) constant volume. Treat the gas as ideal.

7. A sample of ethanol, C_2H_5OH, of mass 23 g, was heated to its boiling point. It was found that an additional 22 kJ was required to vaporize all the ethanol. What is the enthalpy of vaporization of ethanol at its boiling point?

8. Use the following information to construct a heating curve for bromine, Br_2, from −7.2 °C to 70.0 °C. The molar heat of fusion bromine is 75.69 kJ·mol^{-1} and that of bromine vapor is 36.02 kJ·mol^{-1}. For bromine, the specific heat of vaporization 0.225 J·g^{-1}·K^{-1} and of liquid is 0.473 J·g^{-1}·K^{-1}. Bromine melts at −7.2 °C and boils at 58.78 °C. Also calculate the energy to melt 10.0 g of bromine, Br_2.

9. When 0.113 g of benzene, C_6H_6, burns in excess oxygen in a calibrated constant-pressure calorimeter with a heat capacity of 551 J·$(°C)^{-1}$, the temperature of the calorimeter rises by 8.60 °C. Write the thermochemical equation for the reaction 2 $C_6H_6(g)$ + 15 $O_2(g)$ → 12 $CO_2(g)$ + 6 $H_2O(l)$.

10. A constant-volume calorimeter showed that the heat generated by the combustion of 1.000 mol glucose molecules in the reaction $C_6H_{12}O_6(s) + 6\ O_2(g) \rightarrow 6\ CO_2(g) + 6\ H_2O(g)$ is 2559 kJ at 298 K, and so $\Delta U = -2559$ kJ. What is the change in enthalpy for the same reaction?

11. Calculate the standard enthalpy for the following reaction:
$4\ NH_3(g) + 5\ O_2(g) \rightarrow 4\ NO(g) + 6\ H_2O(g)$

	$NH_3(g)$	**$O_2(g)$**	**$NO(g)$**	**$H_2O(g)$**
ΔH_f°(kJ·mol^{-1})	−46.11	0.00	90.25	−241.82

12. Calculate the change in entropy of a large vat of molten copper when 50. J of energy is removed reversibly from it as heat at 1100. °C.

13. Calculate the change in molar entropy of carbon dioxide that is allowed to expand isothermally to 10. times its initial volume (treat carbon dioxide as an ideal gas).

Quick Solutions

1. a) + 33 kJ
b) +12 kJ
2. 1.28 kJ/K
3. 0.18 J/(K g)
4. 0.6 kJ
5. a) + 30 kJ
b) + 40kJ
c) 70 kJ
6. a) +500 J
b) + 700 J
7. 44 kJ/mol
8. 7330 J
9. $2\ C_6H_6(g) + 15\ O_2(g) \rightarrow 12\ CO_2(g) + 6\ H_2O(l)$ $\Delta H = -6.55$ MJ
10. -2544 kJ
11. -905.5 kJ
12. -0.36 J/(K mol)
13. 19 J/(K mol)