CHAPTER REVIEW

For more practice, go to the Problem Bank in Appendix D.

Thermochemistry

SECTION 1 REVIEW

1. How does the enthalpy of the products of a reaction system compare with the enthalpy of the reactants when the reaction is
   a. endothermic?
   b. exothermic?
2. a. Distinguish between enthalpies of reaction, formation, and combustion.
   b. On what basis are enthalpies of formation and combustion defined?
3. Write the equation that can be used to calculate the enthalpy of reaction from enthalpies of formation.
4. What factors affect the value of ΔH in a reaction system?
5. State Hess's law. How is it used?
6. Describe a combustion calorimeter. What information can it give?

PRACTICE PROBLEMS

7. How much energy is needed to raise the temperature of a 55 g sample of aluminum from 22.4°C to 94.6°C? Refer to **Table 1** for the specific heat of aluminum. (Hint: See Sample Problem A.)
8. If 3.5 kJ of energy are added to a 28.2 g sample of iron at 20°C, what is the final temperature of the iron in kelvins? Refer to **Table 1** for the specific heat of iron.
9. You need 70.2 J to raise the temperature of 34.0 g of ammonia, $NH_3(g)$, from 23.0°C to 24.0°C. Calculate the specific heat of ammonia.
10. Calculate c_p for indium metal, given that 1.0 mol In absorbs 53 J while increasing in temperature from 297.5 K to 299.5 K.
11. For each equation listed below, determine the ΔH and type of reaction (endothermic or exothermic).
    a. $C(s) + O_2(g) \longrightarrow CO_2(g) + 393.51\ kJ$
    b. $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l) + 890.31\ kJ$
    c. $CaCO_3(s) + 176\ kJ \longrightarrow CaO(s) + CO_2(g)$
    d. $H_2O(g) \longrightarrow H_2O(l) + 44.02\ kJ$
12. Rewrite each equation below with the ΔH value included with either the reactants or the products, and identify the reaction as endothermic or exothermic.
    a. $H_2(g) + O_2(g) \longrightarrow H_2O(l)$; $\Delta H^0 = -285.83\ kJ$
    b. $2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$; $\Delta H^0 = -1200\ kJ$
    c. $I_2(s) \longrightarrow I_2(g)$; $\Delta H^0 = +62.4\ kJ$
    d. $3CO(g) + Fe_2O_3(s) \longrightarrow 2Fe(s) + 3CO_2(g)$; $\Delta H^0 = -24.7\ kJ$
13. Use Appendix Table A-14 to write the reaction illustrating the formation of each of the following compounds from its elements. Write the ΔH as part of each equation, and indicate the ΔH for the reverse reaction.
    a. $CaCl_2(s)$
    b. $C_2H_2(g)$ (ethyne, or acetylene)
    c. $SO_2(g)$
14. The reaction $2Fe_2O_3(s) + 3C(s) \longrightarrow 4Fe(s) + 3CO_2(g)$ is involved in the smelting of iron. Use ΔH_f values given in Appendix Table A-14 to calculate the enthalpy change during the production of 1 mol of iron.
15. Use enthalpy-of-formation data given in Appendix Table A-14 to calculate the enthalpy of reaction for each of the following. Solve each by combining the known thermochemical equations. Verify each result by using the general equation for finding enthalpies of reaction from enthalpies of formation. (Hint: See Sample Problem B.)
    a. $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$
    b. $Ca(OH)_2(s) \longrightarrow CaO(s) + H_2O(g)$
    c. $Fe_2O_3(s) + 3CO(g) \longrightarrow 2Fe(s) + 3CO_2(g)$
16. For glucose, $C_6H_{12}O_6(s)$, $\Delta H_f = -1263$ kJ/mol. Calculate the enthalpy change when 1 mol of $C_6H_{12}O_6(s)$ combusts to form $CO_2(g)$ and $H_2O(l)$.
17. Calculate the standard enthalpies of reaction for combustion reactions in which ethane, C_2H_6, and benzene, C_6H_6, are the respective reactants and $CO_2(g)$ and $H_2O(l)$ are the products in each. Solve each by combining the known thermochemical equations using the ΔH_f values in