Enthalpies of Reaction

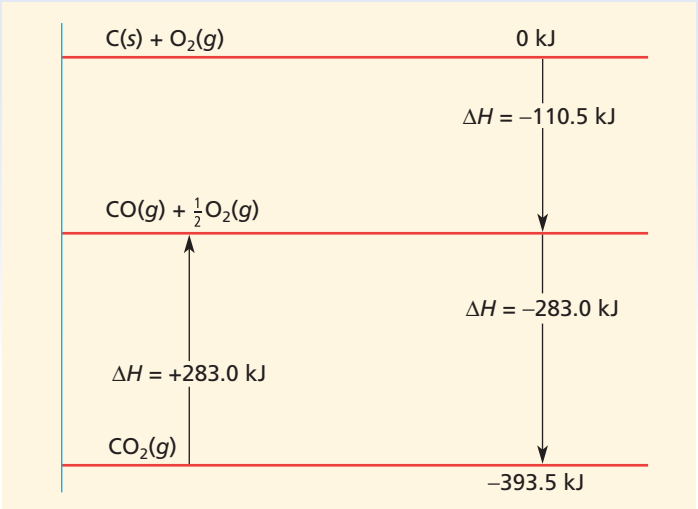

FIGURE 5 This diagram shows the enthalpy of reaction for carbon dioxide, CO_2, and carbon monoxide, CO.

$$C(s) + O_2(g) \longrightarrow \cancel{CO_2(g)} \qquad \Delta H^0 = -393.5 \text{ kJ}$$
$$\cancel{CO_2(g)} \longrightarrow CO(g) + \tfrac{1}{2}\cancel{O_2(g)} \qquad \Delta H^0 = +283.0 \text{ kJ}$$
$$C(s) + \tfrac{1}{2}O_2(g) \longrightarrow CO(g) \qquad \Delta H^0 = -110.5 \text{ kJ}$$

Figure 5 is a model for the process described in this section. If we plot the reactions based on their relative energy, you can see the relationship among the values obtained for the enthalpy of formation of carbon monoxide. The formation of CO_2 is plotted at a level corresponding to –393.5 kJ/mol. The diagram shows the reverse of the combustion reaction (+283.0 kJ/mol) is added to that level. From the diagram, you see the difference, which represents the formation of CO. This value is –110.5 kJ/mol.

SAMPLE PROBLEM C

For more help, go to the Math Tutor at the end of this chapter.

Calculate the enthalpy of formation of pentane, C_5H_{12}, using the information on enthalpies of formation in Appendix Table A-14 and the information on enthalpies of combustion in Appendix Table A-5. Solve by combining the known thermochemical equations.

SOLUTION

1 *ANALYZE*

Given: $C(s) + O_2(g) \longrightarrow CO_2(g)$ $\qquad \Delta H_f^0 = -393.5$ kJ

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$ $\qquad \Delta H_f^0 = -285.8$ kJ

$C_5H_{12}(g) + 8O_2(g) \longrightarrow 5CO_2(g) + 6H_2O(l)$ $\qquad \Delta H_c^0 = -3535.6$ kJ

Unknown: ΔH_f^0 for $5C(s) + 6H_2(g) \longrightarrow C_5H_{12}(g)$