

**Problem 2.6.3** Acetylene can be made by the reaction of carbon and hydrogen. Calculate the equilibrium constant at 2573 °K. Use the following data:

$$2 \text{C}(s) + \text{H}_2(g) \rightleftharpoons \text{C}_2\text{H}_2(g)$$

$$\Delta G_{298} = 50000 \frac{\text{cal}}{\text{mol}}; \quad \Delta H_{298} = 54194 \frac{\text{cal}}{\text{mol}}$$

$$R = 8.32 \frac{\text{J}}{\text{mol} \cdot ^\circ\text{K}}$$

**Solution:** Specific heat data is missing.

$$\begin{aligned} @T &= 298^\circ\text{K} \\ \Delta H_o &= \Delta H = 2.267 \times 10^5 \frac{\text{J}}{\text{mol}} \\ \Delta S &= \frac{\Delta H - \Delta G}{T} = 58.294 \frac{\text{J}}{\text{mol} \cdot ^\circ\text{K}} \\ \Delta S_o &= \Delta S \\ C &= \Delta S_o = 58.924 \frac{\text{J}}{\text{mol} \cdot ^\circ\text{K}} \\ @T &= 2573^\circ\text{K} \\ \Delta G &= \Delta H_o - CT = 7.529 \times 10^4 \frac{\text{J}}{\text{mol}} \\ R \ln K &= -\frac{\Delta H_o}{T} + C = -29.26 \frac{\text{J}}{\text{mol} \cdot ^\circ\text{K}} \\ \rightarrow K &= 0.0297 \end{aligned}$$