6.20 continued

$$f_{HH} \approx V\left(\frac{m_{HH}kT}{2\pi\hbar^2}\right)^{3/2} \cdot \frac{I_{HH}kT}{\hbar^2} \cdot \frac{kT}{\hbar\omega_{HH}};$$

see Note 11 on page 156 of the text. It follows that, at high temperatures,

$$K(T) \approx 4\frac{m_{HD}^3}{m_{HH}^{3/2}m_{DD}^{3/2}} \cdot \frac{I_{HD}^2}{I_{HH}I_{DD}} \cdot \frac{\omega_{HH}\omega_{DD}}{\omega_{HD}^2}. \tag{1}$$

Assuming the internuclear distances to be the same, the I's here will be proportional to the reduced masses of the molecules; the ω's, on the other hand, are inversely proportional to the square roots of the reduced masses. Accordingly,

$$\frac{I_{HD}^2}{I_{HH}I_{DD}} \cdot \frac{\omega_{HH}\omega_{DD}}{\omega_{HD}^2} = \frac{\mu_{HD}^3}{\mu_{HH}^{3/2}\mu_{DD}^{3/2}} = \frac{\{m_H m_D/(m_H+m_D)\}^3}{\left(\frac{1}{2}m_H\right)^{3/2}\left(\frac{1}{2}m_D\right)^{3/2}}. \tag{2}$$

At the same time,

$$\frac{m_{HD}^3}{m_{HH}^{3/2}m_{DD}^{3/2}} = \frac{(m_H+m_D)^3}{(2m_H)^{3/2}(2m_D)^{3/2}}. \tag{3}$$

Substituting (2) and (3) into (1), we see that $K(T) \approx 4$.