51. The fact that they rotate but do not oscillate means that the value of f given in Table 20-3 is relevant. Thus, Eq. 20-46 leads to

$$Q = nC_p\Delta T = n\left(\frac{7}{2}R\right)(T_f - T_i) = nRT_i\left(\frac{7}{2}\right)\left(\frac{T_f}{T_i} - 1\right)$$

where $T_i = 273$ K and $n = 1$ mol. The ratio of absolute temperatures is found from the gas law in ratio form (see Sample Problem 20-1). With $p_f = p_i$ we have

$$\frac{T_f}{T_i} = \frac{V_f}{V_i} = 2 \ .$$

Therefore, the energy added as heat is

$$Q = (1\,\text{mol})\left(8.31\,\frac{\text{J}}{\text{mol}\cdot\text{K}}\right)(273\,\text{K})\left(\frac{7}{2}\right)(2-1) \approx 8\times 10^3\ \text{J} \ .$$