71. (a) Since an ideal gas is involved, then $\Delta E_{\text{int}} = 0$ implies $T_1 = T_0$ (see Eq. 20-62). Consequently, the ideal gas law leads to

$$p_1 = p_0 \left(\frac{V_0}{V_1}\right) = \frac{p_0}{5}$$

for the pressure at the end of the sudden expansion. Now, the (slower) adiabatic process is described by Eq. 20-54:

$$p_2 = p_1 \left(\frac{V_1}{V_2}\right)^{\gamma} = p_1 \left(5^{\gamma}\right)$$

as a result of the fact that $V_2 = V_0$. Therefore,

$$p_2 = \left(\frac{p_0}{5}\right)\left(5^{\gamma}\right) = \left(5^{\gamma-1}\right) p_0$$

which is compared with the problem requirement that $p_2 = 5^{0.4}\, p_0$. Thus, we find that $\gamma = 1.4 = \frac{7}{5}$. Since $\gamma = C_p/C_V$, we see from Table 20-3 that this is a diatomic gas with rotation of the molecules.

(b) The direct connection between E_{int} and K_{avg} is explained at the beginning of §20-8. Since $\Delta E_{\text{int}} = 0$ in the free expansion, then $K_1 = K_0$.

(c) In the (slower) adiabatic process, Eq. 20-56 indicates

$$T_2 = T_1 \left(\frac{V_1}{V_2}\right)^{\gamma-1} = 5^{0.4}\, T_0 \quad \Longrightarrow \quad \frac{(E_{\text{int}})_2}{(E_{\text{int}})_0} = \frac{T_2}{T_0} = 5^{0.4} \approx 1.9 \quad .$$

Therefore, $K_2 = 1.9K_0$.