64. (a) For the isothermal process the final temperature of the gas is $T_f = T_i = 300\,\text{K}$. The final pressure is

$$p_f = \frac{p_i V_i}{V_f} = \frac{(32\,\text{atm})(1.0\,\text{L})}{4.0\,\text{L}} = 8.0\ \text{atm}\ ,$$

and the work done is

$$\begin{aligned} W &= nRT_i \ln\left(\frac{V_f}{V_i}\right) = p_i V_i \ln\left(\frac{V_f}{V_i}\right) \\ &= (32\,\text{atm})(1.01\times10^5\ \text{Pa/atm})(1.0\times10^{-3}\,\text{m}^3)\ln\left(\frac{4.0\,\text{L}}{1.0\,\text{L}}\right) \\ &= 4.4\times10^3\ \text{J}\ . \end{aligned}$$

(b) For the adiabatic process $p_i V_i^\gamma = p_f V_f^\gamma$. Thus,

$$\begin{aligned} p_f &= p_f\left(\frac{V_i}{V_f}\right)^\gamma = (32\,\text{atm})\left(\frac{1.0\,\text{L}}{4.0\,\text{L}}\right)^{5/3} = 3.2\,\text{atm}\ , \\ T_f &= \frac{p_f V_f T_i}{p_i V_i} = \frac{(3.2\,\text{atm})(4.0\,\text{L})(300\,\text{K})}{(32\,\text{atm})(1.0\,\text{L})} = 120\,\text{K}\ , \quad \text{and} \\ W &= Q - \Delta E_{\text{int}} = -\Delta E_{\text{int}} = -\frac{3}{2}nR\Delta T = -\frac{3}{2}(p_f V_f - p_i V_i) \\ &= -\frac{3}{2}[(3.2\,\text{atm})(4.0\,\text{L}) - (32\,\text{atm})(1.0\,\text{L})](1.01\times10^5\ \text{Pa/atm})(10^{-3}\,\text{m}^3/\text{L}) \\ &= 2.9\times10^3\ \text{J}\ . \end{aligned}$$

(c) Now, $\gamma = 1.4$ so

$$\begin{aligned} p_f &= p_i\left(\frac{V_i}{V_f}\right)^\gamma = (32\,\text{atm})\left(\frac{1.0\,\text{L}}{4.0\,\text{L}}\right)^{1.4} = 4.6\ \text{atm}\ , \\ T_f &= \frac{p_f V_f T_i}{p_i V_i} = \frac{(4.6\,\text{atm})(4.0\,\text{L})(300\,\text{K})}{(32\,\text{atm})(1.0\,\text{L})} = 170\ \text{K}\ , \quad \text{and} \\ W &= Q - \Delta E_{\text{int}} = -\frac{5}{2}nR\Delta T = -\frac{5}{2}(p_f V_f - p_i V_i) \\ &= -\frac{5}{2}[(4.6\,\text{atm})(4.0\,\text{L}) - (32\,\text{atm})(1.0\,\text{L})](1.01\times10^5\ \text{Pa/atm})(10^{-3}\,\text{m}^3/\text{L}) \\ &= 3.4\times10^3\ \text{J}\ . \end{aligned}$$