1) Since this is an ideal gas, $\Delta U$ & $\Delta H$ are functions only of $T$ & so at const $T$, they will be unchanged.

\[
\left( \frac{\partial U}{\partial V} \right)_T = \left( \frac{\partial H}{\partial V} \right)_T = \left( \frac{\partial U}{\partial P} \right)_T = \left( \frac{\partial H}{\partial P} \right)_T = 0.
\]
2) \( 1.50 \text{ mol} N_2(g) \)

\[ 25.00^\circ C = 100.00^\circ F \]  \( p_1 \approx p_2 \approx 1 \text{ atm} \)

\( T_1 = 298.15 \text{ K} \)  \( T_2 = 373.15 \text{ K} \)

\[ \text{Work, } W = -\int_{V_1}^{V_2} P \, dV = -P \int_{V_1}^{V_2} dV = -P \Delta V \]

But we don't know the volumes. Since this is an ideal gas we can use \( PV = nRT \)

\[ V_1 = \frac{nRT}{P} = \frac{(1.50 \text{ mol})(1 \text{ atm})(298.15 \text{ K})}{1 \text{ atm}} = 36.70 \text{ L} = 0.03670 \text{ m}^3 \]

To get \( V_2 \) we can use the relation for an ideal gas (Charles' law):

\[ \frac{V_1}{T_1} = \frac{V_2}{T_2} \]

So,

\[ V_2 = \frac{V_1 \cdot T_2}{T_1} = \frac{(36.70 \text{ L})(373.15 \text{ K})}{298.15 \text{ K}} = 45.93 \text{ L} = 0.04593 \text{ m}^3 \]

\[ W = -(1.00 \text{ atm})(10325 \text{ Pa}) \frac{(0.04593 \text{ m}^3 - 0.03670 \text{ m}^3)}{1 \text{ atm}} \]

\[ W = -935.2 \text{ J} \quad [\text{see } p_a = \frac{3}{m}] \]

\[ W = -935.2 \text{ J} \]
1) If this was done at constant volume, work would be zero.
   (since \( w = -P \Delta V \) and \( \Delta V = 0 \)).

2) Since work here is negative, it is done by the system (the system is expanding & using its internal energy in the process by doing work).

3) Since this is done at constant \( P \), \( q = \Delta H \).

\[
\Delta H = \int C_{p,m} \, dT \quad \text{but we need to take into account the } \quad T \text{-dependence of } C_{p,m}.
\]

so \( \Delta H = q_v = \int_{T_i}^{T_f} (1.50 \text{mol}) (25.39 + 0.00809T) \, dT \)

\[
\Delta H = q_v = \int_{T_i}^{T_f} (38.69 + 0.01214T) \, dT
\]

\[
\Delta H = q_v = 38.69T + \frac{1}{2} (0.01214T) T \bigg|_{T_i}^{T_f}
\]

\[
\Delta H = q_v = 38.69 \times 333.15 - 38.69 \times 298.15 + \frac{1}{2} (0.01214 \times 333.15^2 - 0.01214 \times 298.15^2)
\]

\[
\Delta H = q_v = \left[ 2901.75 + 305.61 \right] J
\]

\[
\Delta U = q_v = 3207.37 J
\]

\[
\Delta H = q + w
\]

\[
\Delta H = 3.07 \text{kJ} + (-0.97 \text{kJ})
\]

\[
\Delta L = 2.28 \text{kJ}
\]
3) \( P_1 = 2.00 \text{ atm}, \quad T_1 = 300.00 \text{ K} \)

\( P_2 = ? \quad T_2 = 350.00 \text{ K} \)

\( C_{v,m} = 24.9 \frac{\text{J}}{\text{mol} \cdot \text{K}} \)

Since this is an adiabatic process, \( Q = 0 \)

So \( \Delta U = W = n C_{v,m} \Delta T \)

\[ \Delta U = W = (1.0 \text{ mol})(24.9 \frac{\text{J}}{\text{mol} \cdot \text{K}})(350.00 \text{ K} - 300.00 \text{ K}) \]

\[ \Delta U = W = 1.245 \times 10^3 \text{ J} \]

\[ \Delta U = W = 1.2 \times 10^3 \text{ J} = 1.2 \text{ kJ} \]

Linearly, \( \Delta U = n C_{p,m} \Delta T \frac{C_{v,m} = C_{p,m} + R}{C_{v,m}} \]

\[ \Delta U = (1.0 \text{ mol})(33.2 \frac{\text{J}}{\text{mol} \cdot \text{K}})(50.00 \text{ K}) \]

\[ \Delta U = 1.660 \times 10^3 \text{ J} = 1.7 \text{ kJ} \]

Final volume \( V_2 \)?

Use ideal gas law to get \( V_1 \) & then \( \frac{T_1}{T} = \left( \frac{V_1}{V_2} \right)^y \)

to get \( V_2 \)

\[ y \geq \frac{C_{p,m}}{C_{v,m}} = 1.333 \]

\[ V_1 = nRT \quad \text{or} \quad \frac{nRT}{P_1} = 2.00 \text{ atm} \]

\[ V_1 = 12.20 \text{ L} \]

\[ 
\frac{T_2}{T_1} = \left( \frac{V_1}{V_2} \right)^{y-1} \quad \text{so} \quad \frac{350.00 \text{ K} \cdot V_2^{y-1}}{700.00 \text{ K}} = (12.20 \text{ L})^{0.333} \]

\[ V_2^{0.333} = 1.979 \]

\[ V_2 = 7.75 \text{ L} \quad V_2 = 7.8 \text{ L} \]
Now use $PV_1 = P_2 V_2$ to get $P_2$.

\[ \frac{(2.00 \text{atm})(12.3 \text{L})^{1.33}}{7.8 \text{L}} = P_2 \]

\[ P_2 = 3.67 \text{atm} \]

\[ P_2 = 3.7 \text{atm} \]
(4) \[ P_1 = 7.00 \text{ atm}, \quad T_1 = 300.0 \text{ K}, \quad C_v = 12.5 \text{ cm}^3/\text{mol K} \]

\[ P_2 = \text{?}, \quad T_2 = ? \]

(5) Need \( V_2 \). Ideal gas, so \( PV = nRT \)

\[ V_2 = \frac{nRT}{P} = \frac{(1.0 \text{ mol})(0.08206 \text{ L atm/mol K})(300 \text{ K})}{7.00 \text{ atm}} = 1.20 \text{ L} \]

To get \( V_1 \), we can use \( P_1V_1 = P_2V_2 \)

What is \( \gamma \)?

\[ \gamma = \frac{C_p}{C_v} = \frac{12.5}{12.5} = 1.67 \]

\[ \frac{300 \text{ atm}}{(8.30 \text{ L})} \cdot \frac{1.20 \text{ L}}{1.67} = 2.50 \text{ atm} \cdot 1.17 \]

\[ V_1 = 40.34 \]

\[ V_2 = 9.15 \text{ L} \]

(6) Need \( T_2 \).

\[ T_2 = \frac{V_2}{V_1} = \frac{9.15}{1.17} \]

\[ T_2 = 2.5 \cdot 10^4 \text{ K} \]

(7) Work done

Since \( h_2 \) is an adiabatic expansion, \( q = 0 \) so \( \Delta U = 0 = \int_{C_{ad}} w \)

\[ w = \frac{1}{(12.5 \text{ cm}^3/\text{mol})(1.0 \text{ mol})} (328 \text{ J} - 200 \text{ J}) \]

\[ w = -263.9 \text{ J} \]

\[ (\omega = -0.26 \text{ kJ}) \]