$V_A = 91369\ mm^3 = 91.369 \cdot 10^{-6}\ m^3$
$V_B = 87221\ mm^3 = 87.221 \cdot 10^{-6}\ m^3$
$V_C = 129529\ mm^3 = 129.529 \cdot 10^{-6}\ m^3$
$V_D = 131189\ mm^3 = 131.189 \cdot 10^{-6}\ m^3$
$V_{A'} = 87221\ mm^3 = 87.221 \cdot 10^{-6}\ m^3$

$P_A = 101325\ Pa$
$P_B = 106144\ Pa$
$P_C = 106144\ Pa$
$P_D = 104800\ Pa$
$P_{A'} = 104800\ Pa$

A → B: Isothermal Compression

$$P_A V_A = P_B V_B \rightarrow P_B = P_A\left(\frac{V_A}{V_B}\right) = (101325\ Pa)\left(\frac{91.369 \cdot 10^{-6}\ m^3}{87.221 \cdot 10^{-6}\ m^3}\right) = 106144\ Pa$$

$$W_{A\rightarrow B} = P_A V_A \ln\left(\frac{V_B}{V_A}\right) = (101325\ Pa)(91.369 \cdot 10^{-6}\ m^3)\ln\left(\frac{87.221 \cdot 10^{-6}\ m^3}{91.369 \cdot 10^{-6}\ m^3}\right)$$

$$= -430.14\ mJ$$

$$\Delta U = U_B - U_A = U(T_B) - U(T_A) = 0 \therefore Q_{A\rightarrow B} = -430.14\ mJ$$

B → C: Isobaric Expansion

$$W_{B\rightarrow C} = P_B(V_C - V_B) = (106144\ Pa)(129.529 - 87.221) \cdot 10^{-6}\ m^3$$

$$= 4490.74\ mJ$$

$$Q_{B\rightarrow C} = mC_p(T_C - T_B) = V_A \rho_A C_p(T_C - T_B)$$

$$= (91.369 \cdot 10^{-6}\ m^3)\left(1.292\ \frac{kg}{m^3}\right)\left(1.0\ \frac{kJ}{kg \cdot K}\right)(100 - 0)\ K = 11804.87\ mJ$$

C → D: Isothermal Expansion

$$P_D = P_C\left(\frac{V_C}{V_D}\right) = (106144\ Pa)\left(\frac{129.529 \cdot 10^{-6}\ m^3}{131.189 \cdot 10^{-6}\ m^3}\right) = 104800\ Pa$$

$$W_{C\rightarrow D} = P_C V_C \ln\left(\frac{V_D}{V_C}\right) = (106144\ Pa)(129.529 \cdot 10^{-6}\ m^3)\ln\left(\frac{131.189 \cdot 10^{-6}\ m^3}{129.529 \cdot 10^{-6}\ m^3}\right)$$

$$= 175.08\ mJ$$

$$Q_{C\rightarrow D} = 175.08\ mJ$$

D → A': Isobaric Compression

$$W_{D\rightarrow A'} = P_D(V_{A'} - V_D) = (104800\ Pa)(87.221 - 131.189) \cdot 10^{-6}\ m^3$$

$$= -4607.85\ mJ$$

$$Q_{D\rightarrow A'} = mC_p(T_{A'} - T_D) = V_A \rho_A C_p(T_{A'} - T_D) = -11804.87\ mJ$$

$V_A = 91.369 \cdot 10^{-6}\ m^3$

$V_B = 87.221 \cdot 10^{-6}\ m^3$

$V_C = 117.086 \cdot 10^{-6}\ m^3$

$V_D = 120.404 \cdot 10^{-6}\ m^3$

$V_{A'} = 88.880 \cdot 10^{-6}\ m^3$

$P_A = 101325\ Pa$

$P_B = 106144\ Pa$

$P_C = 106144\ Pa$

$P_D = 103218\ Pa$

$P_{A'} = 103218\ Pa$

$W_{A\to B} = -430.14\ mJ$

$Q_{A\to B} = -430.14\ mJ$

$W_{B\to C} = 3169.99\ mJ$

$Q_{B\to C} = 9443.10\ mJ$

$W_{C\to D} = 347.29\ mJ$

$Q_{C\to D} = 347.29\ mJ$

$W_{D\to A'} = -3253.87\ mJ$

$Q_{D\to A'} = -9443.90\ mJ$

IWC

$$UW_{A\to B} = \left(\frac{135}{1000}\ kg\right)\left(9.81\ \frac{m}{s^2}\right)\left(\frac{20-25}{1000}\ m\right) = -6.62\ mJ$$

$$UW_{B\to C} = \left(\frac{135}{1000}\ kg\right)\left(9.81\ \frac{m}{s^2}\right)\left(\frac{71-20}{1000}\ m\right) = 67.54\ mJ$$

$$UW_{C\to D} = \left(\frac{35}{1000}\ kg\right)\left(9.81\ \frac{m}{s^2}\right)\left(\frac{73-71}{1000}\ m\right) = 0.69\ mJ$$

$$UW_{D\to A'} = \left(\frac{35}{1000}\ kg\right)\left(9.81\ \frac{m}{s^2}\right)\left(\frac{20-73}{1000}\ m\right) = -18.20\ mJ$$

RWC

$UW_{A\to B} = -6.62\ mJ$

$UW_{B\to C} = 47.68\ mJ$

$UW_{C\to D} = 1.37\ mJ$

$UW_{D\to A'} = -13.05\ mJ$