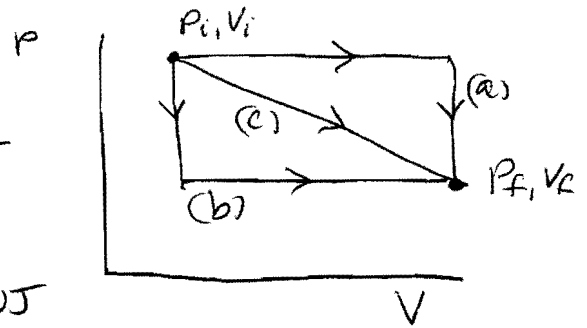


①

$$(a) W = -P_i(V_f - V_i) + 0 \\ = -(15 \text{ Pa})(5.0 \text{ m}^3 - 1.0 \text{ m}^3) = -60 \text{ J}$$

$$(b) W = 0 - P_f(V_f - V_i) \\ = -(5 \text{ Pa})(5.0 \text{ m}^3 - 1.0 \text{ m}^3) = -20 \text{ J}$$



$$(c) W = \text{area below line} = \text{area of triangle} + \text{work from (b)} \\ \text{area of triangle} = -\frac{1}{2}(5.0 \text{ m}^3 - 1.0 \text{ m}^3)(15 \text{ Pa} - 5 \text{ Pa}) = -20 \text{ J}$$

$$W = -20 \text{ J} - 20 \text{ J} = -40 \text{ J}$$

$$(2) T = \frac{PV}{nR} = \frac{(1.32 \text{ atm})(1.01 \times 10^5 \text{ Pa/atm})(22.4 \text{ L})(10^{-3} \text{ m}^3/\text{L})}{(1.12 \text{ mole})(8.31 \text{ J/mole}\cdot\text{K})}$$

$$= 321 \text{ K}$$

$$W = -nRT \ln \frac{V_f}{V_i} = -(1.12 \text{ mole})(8.31 \frac{\text{J}}{\text{mole}\cdot\text{K}})(321 \text{ K}) \ln \frac{15.3 \text{ L}}{22.4 \text{ L}}$$

$$= 1.14 \text{ kJ}$$

$$(3) (a) W = -P(V_f - V_i) = (1.00 \text{ atm})(1.01 \times 10^5 \text{ Pa/atm})(113 \text{ cm}^3 - 63 \text{ cm}^3)(10^{-6} \text{ m}^3/\text{cm}^3)$$

$$= -5.05 \text{ J}$$

$$\Delta E_{\text{int}} = Q + W = 20.9 \text{ J} - 5.05 \text{ J} = 15.9 \text{ J}$$

$$(b) Q = n C_p (T_f - T_i) = n C_p \left(\frac{P_f V_f}{nR} - \frac{P_i V_i}{nR} \right)$$

$$C_p = \frac{RQ}{P_f V_f - P_i V_i} = \frac{(8.31 \text{ J/mole}\cdot\text{K})(20.9 \text{ J})}{(1.00 \text{ atm})(1.01 \times 10^5 \frac{\text{Pa}}{\text{atm}})(113 \text{ cm}^3 - 63 \text{ cm}^3)(10^{-6} \text{ m}^3/\text{cm}^3)}$$

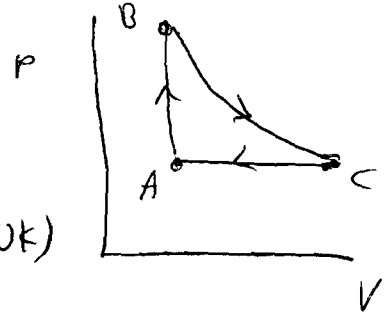
$$= 34.4 \text{ J/mole}\cdot\text{K}$$

$$(c) C_v = C_p - R = 26.1 \text{ J/mole}\cdot\text{K}$$

④

A → B:

$$\begin{aligned}
 Q &= n C_V (T_B - T_A) \\
 &= (1.00 \text{ mole}) \left(\frac{3}{2} \cdot 8.31 \frac{\text{J}}{\text{mole} \cdot \text{K}} \right) (600 \text{K} - 300 \text{K}) \\
 &= 3740 \text{ J}
 \end{aligned}$$



$$W = 0$$

$$\Delta E_{\text{int}} = Q + W = 3740 \text{ J}$$

B → C: $Q = 0$

$$\begin{aligned}
 \Delta E_{\text{int}} &= n C_V (T_C - T_B) = (1.00 \text{ mole}) \left(\frac{3}{2} \cdot 8.31 \frac{\text{J}}{\text{mole} \cdot \text{K}} \right) (455 \text{K} - 600 \text{K}) \\
 &= -1810 \text{ J}
 \end{aligned}$$

$$W = \Delta E_{\text{int}} - Q = -1810 \text{ J}$$

C → A: $Q = n C_P (T_A - T_C)$

$$= (1.00) \left(\frac{5}{2} \times 8.31 \right) (300 - 455) = -3220 \text{ J}$$

$$\Delta E_{\text{int}} = n C_V (T_A - T_C) = (1.00) \left(\frac{3}{2} \times 8.31 \right) (300 - 455) = -1930 \text{ J}$$

$$W = \Delta E_{\text{int}} - Q = 1290 \text{ J}$$

cycle: $Q = 520 \text{ J}$

$$W = -520 \text{ J}$$

$$\Delta E_{\text{int}} = 0$$