

(b)

$$W_{12} = \int_{V_1}^{V_2} P_1 dV = P_1(V_2 - V_1) = (5 \times 10^5 \text{ Pa})(1 \text{ m}^3 - 0.2 \text{ m}^3) = 4 \times 10^5 \text{ J}$$

$$W_{23} = 0 \quad \because \Delta V = 0$$

$$T_1 = T_3$$

$$\Delta Q_p = \Delta U_{12} + W_{12}$$

$$P_1 V_1 = nRT_1$$

$$nC_p dT = nC_v dT + W_{12}$$

$$P_2 V_2 = nRT_2$$

$$nR dT = W_{12}$$

$$P_3 V_3 = nRT_3$$

$$nR(T_2 - T_1) = 4 \times 10^5$$

$$T_2 - T_1 = \frac{4 \times 10^5}{nR} \dots \textcircled{1}$$

$$\frac{P_1 V_1}{P_2 V_2} = \frac{T_1}{T_2} \Leftrightarrow T_1 = \frac{P_1 V_1}{P_2 V_2} T_2 = \frac{1 \times 10^5}{5 \times 10^5} T_2 = \frac{1}{5} T_2 \dots \textcircled{2}$$

$$\therefore \textcircled{1} \text{ \& } \textcircled{2} \quad 5T_1 - T_1 = \frac{4 \times 10^5}{nR}$$

$$T_1 = \frac{1 \times 10^5}{nR}$$

$$W_{31} = \int_{V_2}^{V_1} \frac{nRT_1}{V} dV$$

$$= 1 \times 10^5 [\ln V]_{V_2}^{V_1} = 1 \times 10^5 \ln \frac{V_1}{V_2}$$

$$= \ln(0.2) \times 10^5$$

$$\approx -160943 \text{ J}$$

$$W_{12} = 400 \text{ kJ}$$

$$W_{23} = 0 \text{ kJ}$$

$$W_{31} = -161 \text{ kJ}$$