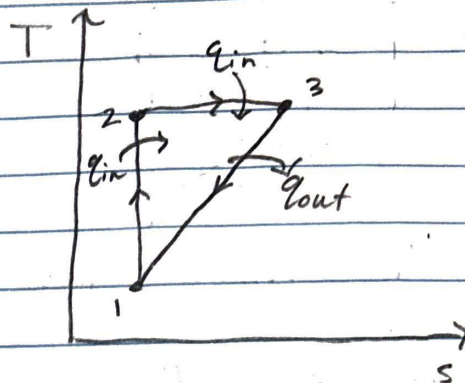
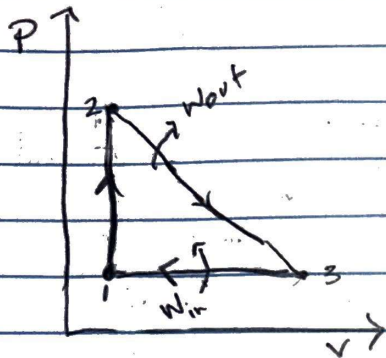


Thermal Apps Homework 1.2

9-13

(a)



$$C_p = 1.005 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$$

$$R = 0.287 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$$

$$k = 1.4$$

$$C_v = 0.718 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$$

Constant process $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

(1)

$$P_1 = 100 \text{ kPa}$$

$$T_1 = 27^\circ\text{C} + 273\text{K} = 300\text{K}$$

$$V_1 = \frac{R T_1}{P_1} = \frac{(0.287)(300)}{100}$$

$$= 0.861 \text{ m}^3/\text{kg}$$

(2)

$$P_2 = 700 \text{ kPa}$$

$$T_2 = \frac{P_2}{P_1} T_1$$

$$T_2 = \frac{700}{100} (300)$$

$$T_2 = 2100\text{K}$$

$$V_2 = \frac{(0.287)(2100)}{700} = 0.861 \text{ (Isothermal)}$$

(3)

$$V_3 = 7 V_2$$

$$V_3 = 7(0.861) = 6.027 \text{ m}^3/\text{kg}$$

$$P_3 = P_1 = 100 \text{ kPa}$$

$$T_3 = 2100$$

(b)

$$\frac{W_{\text{comp}}}{W_{\text{exp}}} = \frac{W_{\text{in } 3-1}}{W_{\text{out } 2-3}}$$

$$W_{\text{out } 2-3} = (0.287)(2100) \ln \left(\frac{6.027}{0.861} \right) = 1172.8 \text{ kJ}$$

$$W_{\text{in } 3-1} = (100)(6.027 - 0.861) = 516.6 \text{ kJ}$$

$$\frac{516.6}{1172.8} = 0.44$$

(c)

$$W_{\text{net}} = 1172.8 - 516.6 = 656.2 \text{ kJ}$$

$$q_{\text{in}} = 1172.8 + 1292.4 = 2465.2 \text{ kJ}$$

$$q_{\text{in } 1-2} = (0.718)(2100 - 300) = 1292.4$$

$$\eta_{\text{th}} = \frac{656.2}{2465.2} = 0.266 = 26.6\%$$