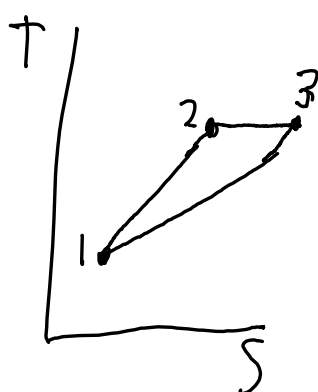
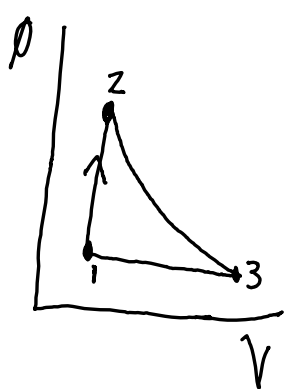


13)

1-2

constant Heat

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

$$T = 27^\circ\text{C} = 300 \text{ K}$$

$$P_2 = 850 \text{ kPa}$$

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

$$\frac{850}{100} = \frac{T_2}{300 \text{ K}} = 2550 \text{ K}$$

2-3

Isothermal

expansion

$$\text{until } V_3 = 7V_2$$

3-1
 $P = \text{constant}$ Heat rejection

$$C_v = 0.718$$

$$C_p = 1.005$$

$$k = 0.287$$

$$k = 1.4$$

$$W_{1-2} = P(V_2 - V_1)$$

$$Pv = RT$$

$$W_{1-2} = (0.287) (200 - 2550) = -645.76 \frac{\text{kJ}}{\text{kg}}$$

$$W_{2-3} = RT \ln \left(\frac{V_3}{V_2} \right) = (0.287) (2550) (\ln(7)) = 1566.21$$

$$P_2 V_2 = P_3 V_3$$

$$\frac{V_3}{V_2} = \frac{P_2}{P_3} = \frac{850}{100} = 8.5 = \frac{V_3}{V_2}$$

$$\text{Back work} = \frac{645.76}{1566.21} = \boxed{0.41}$$

C

$$Q = C_v(T_2 - T_1)$$

$$Q = 0.718 (2550 - 300) = 1615.5 \frac{\text{kJ}}{\text{kg}}$$

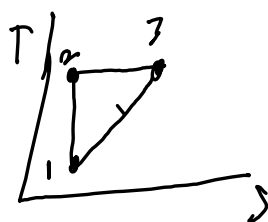
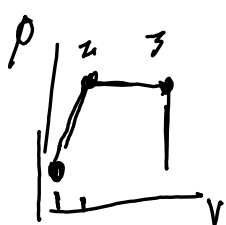
$$Q_{2-3} = W_{2-3} = 1566.21$$

$$Q_{in} = 1010 + 1067 = 3183 \frac{\text{kJ}}{\text{kg}}$$

$$W_{net} = 1567 - 645.76 = 921 \frac{\text{kJ}}{\text{kg}}$$

$$\eta = \frac{W_{net}}{Q_{in}} = \frac{921}{3183} = 0.289 \cdot 100 = \boxed{28.9\%}$$

18



$$\begin{array}{ccc} \frac{1-2}{T=20^\circ\text{C} = 293\text{K}} & \frac{2-3}{\text{constant } P} & \frac{3-1}{\text{constant } V} \\ & \text{heat add.} & \text{heat rej.} \end{array}$$

$$r=5$$

$$C_v = 0.7$$

$$R = 0.7$$

$$C_p = C_v + R = 0.7 + 0.7 = 1 \text{ kJ/kg} \cdot \text{K}$$

$$\gamma = \frac{1}{0.7} = 1.43$$

$$T_2 = T_1 r^{\gamma-1} \quad T_3 = T_2 r = 557.7 \text{ (s)}$$

$$T_3 = 2788.95 \text{ K}$$

$$T_2 = 293 \cdot 5^{0.4} = 557.77 \text{ K}$$

$$Q_{12} = 0$$

$$W_{12} = C_v (T_1 - T_2)$$

$$W_{12} = 0.7 (293 - 558) = -186 \frac{\text{kJ}}{\text{kg}}$$

$$Q_{23} = C_p (T_3 - T_2)$$

$$Q_{23} = (1) (2788.95 - 557.77) = 2231.1$$

$$W_{23} = R (T_3 - T_2) = 0.7 (2788.9 - 557.8)$$

$$W_{23} = 669.83$$

$$Q_{31} = C_v (T_1 - T_3) = 0.7 (293 - 2788.9)$$

$$Q_{31} = -1747 \frac{\text{kJ}}{\text{kg}}$$

$$W_{\text{net}} = -186 + 669.83 = \boxed{483.33 \frac{\text{kJ}}{\text{kg}}}$$

$$\eta = \frac{483.33}{2231.1} = 0.22 \cdot 100 = \boxed{22\%}$$

$$T_2 = T_1 r^{\gamma-1} \quad T_3 = T_1 r^\gamma$$

$$Q_{\text{in}} = C_p (T_3 - T_2)$$

$$Q_{\text{out}} = C_v (T_3 - T_1)$$

$$\boxed{\eta = \frac{1 - C_v (r^\gamma - 1)}{C_p (r^\gamma - r^{\gamma-1})}}$$

22

$$m = 0.6 \text{ kg}$$

$$T_1 = 300 \text{ K}$$

$$T_2 = 1100 \text{ K}$$

$$P_{\min} = 20 \text{ kPa}$$

$$P_{\max} = 3000 \text{ kPa}$$

$$\eta = 1 - \frac{T_1}{T_2} = 1 - \frac{300}{1100} = 0.727$$

$$Q_H = m R T_H \ln\left(\frac{V_2}{V_1}\right)$$

$$Q_H = (0.6)(0.287)(1100) \ln(1.59)$$

$$Q_H = 87.8 \text{ kJ}$$

$$W_{\text{net}} = \eta Q_H = 0.727 \cdot 87.8$$

$$W_{\text{net}} = 63.86 \text{ kJ}$$

31]

Gasoline engines mix air and fuel and then compress it for ignition.

diesel engines compress only air to a high temperature then inject fuel to ignite