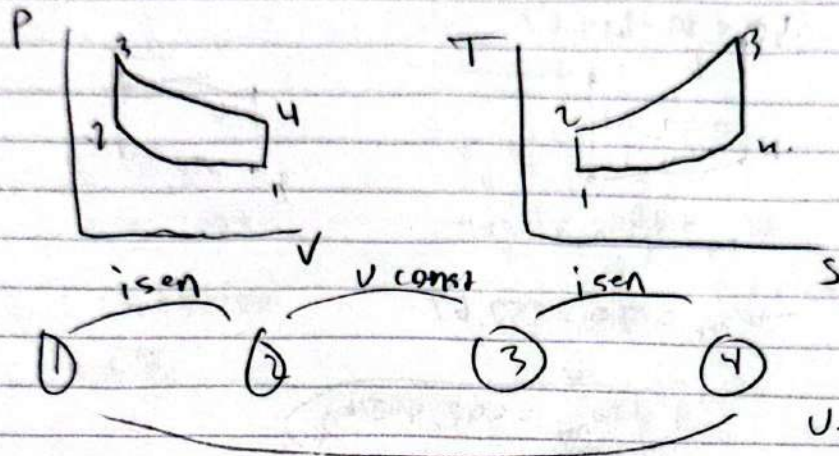


9.33

$r = 8$



$$P_1 = 95 \text{ kPa}$$

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

$$Pv = RT$$

$$v = \frac{RT}{P}$$

$$v = \frac{(0.287)(300)}{95}$$

$$v_1 = 0.906$$

$$v_2 = \frac{v_1}{r}$$

$$v_2 = \frac{0.906}{8}$$

$$v_2 = 0.11325$$

$$\frac{v_1}{v_2} = 8$$

$$\frac{0.906}{v_2} = 8$$

$$v_2 = 0.11325$$

Interpolation
RPP
Table A-17

$$T_2 = 673.1 \text{ K}$$

$$Pv = RT$$

$$P = \frac{RT}{v}$$

$$P_2 = \frac{(0.287)(673.1)}{0.11325}$$

$$P_2 = 1705.7 \text{ kPa}$$

$v \text{ const}$

$$v_3 = 0.11325$$

$$T_3 = 1539 \text{ K}$$

$$v_{R3} = 6.588$$

$$\frac{P_2 v_2}{T_2} = \frac{P_3 v_3}{T_3}$$

$$P_3 = 1705.1 \left(\frac{1539}{673.1} \right)$$

$$P_3 = 3890 \text{ kPa}$$

$$T_3 = 1539 \text{ K}$$

$$u_3 - u_2 = Q = 750 \text{ kJ/kg}$$

$$u_3 = 1241.2 \text{ kJ/kg}$$

$$\frac{u_4}{v_4} = 8 = \frac{u_3}{v_3}$$

$$u_{R4} = 52.7$$

$$T_4 = 774.5 \text{ K}$$

$$Q_{out} = U_1 - U_4$$

$$571.69 - 214.07$$

↓

$$= 357.62$$

$$W_{net} = Q_{in} - Q_{out}$$

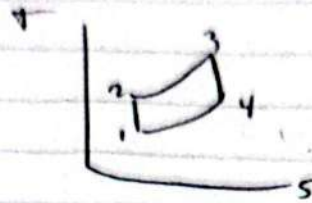
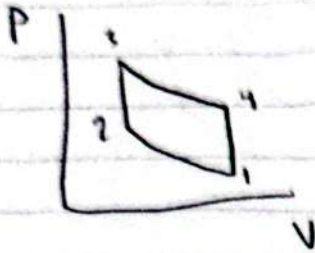
$$W_{net} = 750 - 357.62$$

↓

$$W_{net} = 392.4 \text{ kJ/kg}$$

$$\eta = \frac{Q_{out}}{Q_{in}} = \frac{392.4}{750} = 52.3\%$$

$$MEP = \frac{W}{\Delta V} = \frac{392.4}{1.133 - 0.006} = 4956 \text{ Pa}$$



$$P_1 = 96.52 \text{ kPa}$$

$$T_1 = 313.706 \text{ K}$$

$$T_3 = 1588.706$$

$$V_2 = 9.8\%$$

$$T_1 V_1^{k-1} = T_2 V_2^{k-1}$$

$$T_2 = T_1 \left(\frac{V_1}{V_2} \right)^{k-1}$$

$$T_2 = 313 \left(\frac{V_1}{9.8\% V_1} \right)^{k-1} = 792.5 \text{ K}$$

$$T_3 V_3^{k-1} = T_4 V_4^{k-1}$$

$$T_4 = T_3 \left(\frac{V_3}{V_4} \right)^{k-1}$$

$$T_4 = 1573 \left(\frac{V_3 \cdot 9.8\%}{V_4} \right)^{k-1}$$

$$T_4 = 621.3 \text{ K}$$

$$A_p = \pi \left(\frac{0.029 \text{ m}}{2} \right)^2$$

$$6.22 \times 10^{-3} \text{ m}^2$$

$$\Delta V = 6.16 \times 10^{-4}$$

$$W = Q_{in} - Q_{out}$$

$$W = C_v (T_3 - T_2) - C_v (T_4 - T_1)$$

$$W_{out} = .710 (757.3 - 792.5)$$

$$= .710 (621.3 - 313)$$

$$W_{out} = 339 \text{ J/kg}$$

$$P_1 V_1 = M R T$$

$$\frac{V}{M} = \frac{P_1}{P_1} = \frac{.787(313)}{95404}$$

$$\frac{V_1}{M} = V_1 = .9656$$

$$m = \frac{V}{V_1} = \frac{6.16 \times 10^{-5}}{.9456}$$

$$M = 6.51 \times 10^{-4} \text{ kg}$$

$$M_T = 6 \cdot m = 3.9 \times 10^{-3} \text{ kg}$$

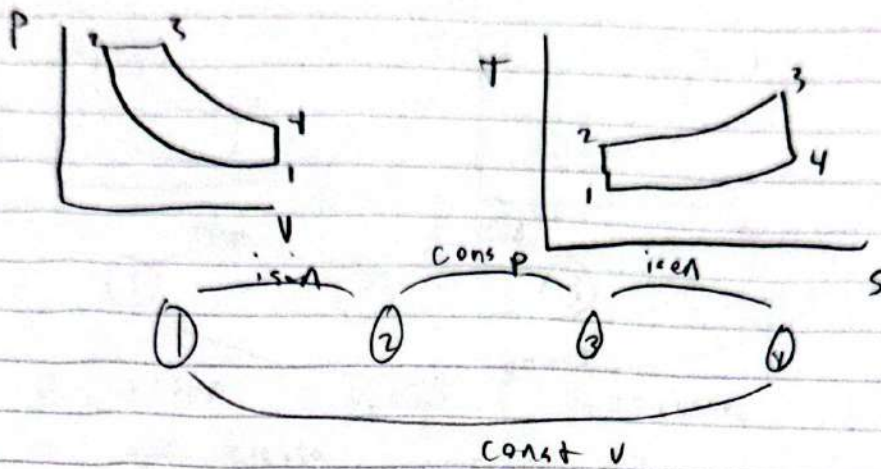
$$337 \cdot 3.9 \times 10^{-3}$$

$$W = 1.325 \text{ kJ/cycle}$$

$$\text{Power} = \frac{2500 \text{ rev}}{\text{min}} \left(\frac{1 \text{ min}}{60 \text{ s}} \right) \left(\frac{1.325 \text{ kJ}}{1 \text{ rev}} \right)$$

$$\text{Power} = 27.6 \text{ kW}$$

9-46



$$P_1 = 95 \text{ kPa} \quad V_2 = \frac{V_1}{r}$$

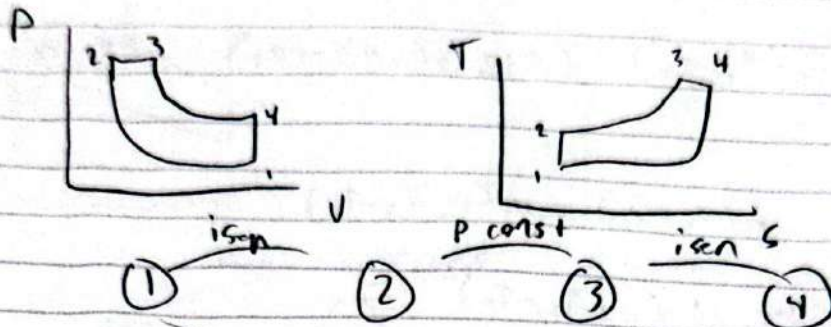
$$T_1 = 17^\circ\text{C} = 300\text{K} \quad V_2 = \frac{.906}{10}$$

$$V_1 = \frac{R T_1}{P_1} \quad V_2 = .0566$$

$$V_1 = \frac{.287(300)}{95} \quad \frac{V_1}{V_2} = \frac{T_1}{T_2}$$

$$V_1 = .906 \quad \frac{.906}{.0566} = \frac{300}{T_2}$$

9-57



$$P_1 = 97 \text{ kPa}$$

$$T_1 = 70^\circ\text{C} = 343.15 \text{ K}$$

$$V_1 = \frac{RT_1}{P_1}$$

$$V_1 = \frac{(0.287)(343.15)}{97}$$

$$V_1 = 1.015$$

$$V_2 = \frac{V_1}{r}$$

$$V_2 = \frac{1.015}{22}$$

$$V_2 = 0.04613$$

$$T_2 = T_1 \left(\frac{V_1}{V_2} \right)^{\gamma-1}$$

$$T_2 = (343)(22)^{0.4}$$

$$T_2 = 1181 \text{ K}$$

$$P_2 = \frac{RT_2}{V_2}$$

$$P_2 = \frac{(0.287)(1181)}{0.04613}$$

$$P_2 = 7346 \text{ kPa}$$

$$P_3 = 7346 \text{ kPa}$$

$$V_3 = V_2 V_2$$

$$V_3 = 1.8(0.04613)$$

$$V_3 = 0.08303$$

$$T_3 = \frac{P_3 V_3}{R}$$

$$T_3 = \frac{7346(0.08303)}{0.287}$$

$$T_3 = 2126 \text{ K}$$

$$V_4 = 1.015$$

$$T_4 = T_3 \left(\frac{V_3}{V_4} \right)^{\gamma-1}$$

$$T_4 = 2126 \left(\frac{0.08303}{1.015} \right)^{0.4}$$

$$T_4 = 781 \text{ K}$$

$$w_{1-2} = c_v (T_1 - T_2) = (.718)(343 - 1181) = -601.7$$

$$Q_{2-3} - w_{2-3} = m(u_3 - u_2) = m c_v (T_3 - T_2)$$

$$q_{2-3} = w_{2-3} + c_v (T_3 - T_2)$$

$$w_{2-3} = p(v_3 - v_2) = 73.48(.08303 - .04613)$$

$$w_{2-3} = 271.1$$

$$q = (271.1) + (.718)(2126 - 1181) = 949.7$$

$$w_{3-4} = c_v (T_3 - T_4) = (.718)(2126 - 781) = 965.7$$

$$q_{4-1} = c_v (T_1 - T_4) = (.718)(343 - 781) = -314.5$$

$$m = \frac{V_2}{V_1} = \frac{2.4^2}{1.015} = 2.364 \times 10^{-3}$$

$$w_{net} = w_{1-2} + w_{2-3} + w_{3-4} + w_{4-1}$$

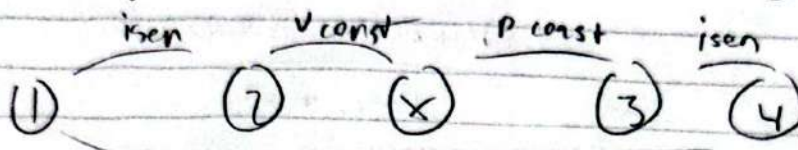
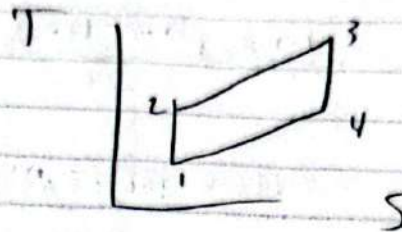
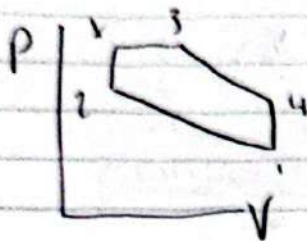
$$w_{net} = (-601.7) + (271.1) + (965.7) + 0 = 635.1 \text{ kJ/kg}$$

$$W_{net} = (2.364 \times 10^{-3})(635.1) = 1.501$$

$$w_{net} = \frac{W_{net}}{n_{rev}} = \frac{1.501(3500)(\frac{\text{min}}{60})}{1 \frac{\text{rev}}{\text{cy}}}$$

$$W_{net} = 97.59 \text{ kW}$$

q-59



$$T_1 = 75^\circ\text{C} = 451.67\text{K}$$

$$P_1 = 14.2 \text{ psia}$$

$$V_1 = \frac{.707(53.67)}{14.2}$$

$$V_1 = 10.8$$

$$V_2 = r r_1 V \text{ const}$$

$$V_2 = 16.2$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$T_2 = 451.67 \left(\frac{10.8}{16.2}\right)^{1.4}$$

$$T_2 = 1579.5$$

$$P_2 = \frac{R T_2}{V_2}$$

$$P_2 = \frac{.287(1579.5)}{16.2}$$

$$P_2 = 7.8 \text{ psia}$$

$$V_3 = 10.2$$

$$P_3 = 1.1 P_2$$

$$P_3 = 3.08$$

$$T = \frac{3.08(16.2)}{.287}$$

$$T_3 = 1732.5$$

$$P_3 = 3.08$$

$$V_3 = V_2 R_2$$

$$V_3 = 226.8$$

$$T = \frac{P V}{R} = \frac{3.08(226.8)}{.287}$$

$$T_3 = 2432.9\text{R}$$

$$V_4 = 10.8$$

$$\frac{T_4}{T_3} = \left(\frac{V_3}{V_4}\right)^{\gamma-1}$$

$$T_4 = 2432.9 \left(\frac{226.8}{10.8}\right)^{1.4}$$

$$T_4 = 720\text{R}$$

$$P_4 = \frac{R T_4}{V_4}$$

$$P_4 = \frac{.287(720)}{10.8}$$

$$P_4 = 19.13$$

$$(v_2 - v_r)(P_r) + \left(\frac{m v_2 - P_r v_2}{1 - 1.4} \right) - \left(\frac{P_r v_1 - P_r v_1}{1 - 1.4} \right)$$

$$(226.8 - 162)(3.08) + \left(\frac{19.13(10.8) - 73.08(176.8)}{1 - 1.4} \right)$$

$$(2.8)(162) + (14.2)(10.8)$$

$$1 - 1.4$$

$$199.584 + 1229.0 - 756.0$$

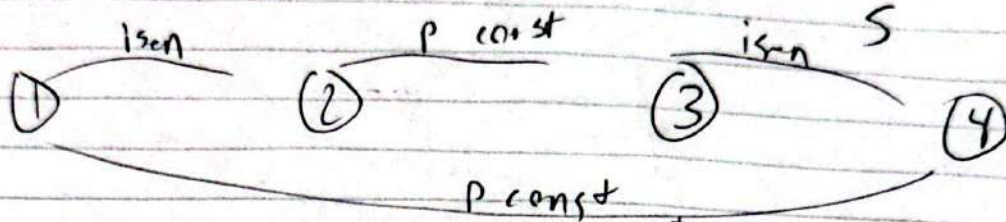
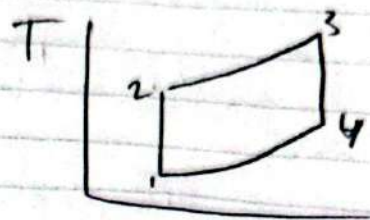
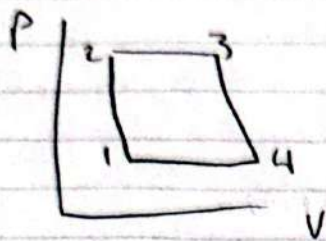
$$w_{net} = 678.784$$

$$\eta_{th} = 1 - \frac{1}{r^{k-1}} \left(\frac{r_c^k - 1}{k(r_c - 1)} \right)$$

$$1 - \frac{1}{15^{1.4}} \left(\frac{1.4^{1.4} - 1}{1.4(1.4 - 1)} \right)$$

$$\eta_{th} = .636 = 63.6\%$$

9-80



$$T_1 = 570 \text{ R}$$

$$P_2 = 10 P_1$$

$$T_3 = 2000 \text{ R}$$

$$P_4 = 1.1$$

$$P_{r1} = 1.2147$$

$$P_{r2} = 12.147$$

$$P_3 = 174$$

$$P_{r3} = 17.4$$

$$T_4 = 1097.31 \text{ R}$$

$$T_2 = 996.48 \text{ R}$$

$$h_1 = 124.27$$

$$h_2 = 740.11$$

$$h_3 = 504.71$$

$$h_4 = 265.83$$

$$a \quad T_2 = 996.48$$

$$210.11 - 124.27$$

b

$$w_{in_{1-2}} = h_2 - h_1 = 115.84$$

$$564.71 - 265.83$$

$$w_{out_{3-4}} = h_3 - h_4 = 298.88$$

$$\frac{w_{com}}{w_{el}} = .485$$

c

$$\eta_{th} = \frac{w_{net}}{q_{in}} = \frac{w_{out_{3-4}} - w_{in_{1-2}}}{q_{in_{2-3}}}$$

$$q_{in_{2-3}} = h_3 - h_2$$

$$564.71 - 290.11 = 274.64$$

$$\eta_{th} = .465$$