$Q_3 - W_3 = m(u_3 - u_2) = m C_v (T_3 - T_2)$ $Q = C_v(T_3 - T_2) = .171(2860 - 1431) = 244.3$

$P_3 = \frac{RT}{v} = \frac{.3704 \cdot 2860}{1.465} = 723.1$ $v_4 = v_1 = 14.95$ $s_4 = s_3$

$T_4 = T_3\left(\frac{v_3}{v_4}\right)^{k-1} = 2860\left(\frac{1.465}{14.95}\right)^{.4} = 1129\,R$ $P_4 = \frac{RT_4}{v_4} = \frac{.3704(1129)}{14.95} = 27.98\,psia$

$W_4 = C_v(T_3 - T_4) = .171(2860 - 1129) = 296$ $Q_4 = C_v(T_1 - T_4) = .171(565 - 1129) = -96.44$

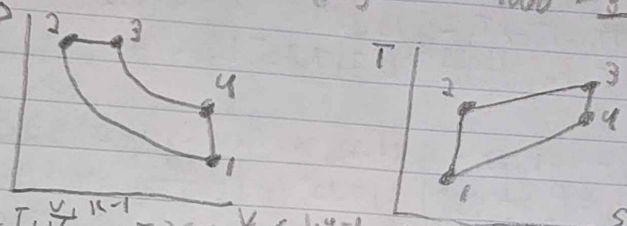
$V_{net} = -148.1 + 0 + 296 + 0 = 147.4$ $v = \frac{V}{m}$ $m = \frac{V_{DISP}}{v_1}$

$V_{disp} = 6\left(\frac{\pi}{4}D^2 \cdot S\right) = \frac{3\pi}{2}(.1917)^2(.325) = .1809\,ft$

$m = \frac{1129}{14.95} = 8.717 \cdot 10^{-3}$ $W_{net} = m \cdot w_{net} = 8.717 \cdot 10^{-3}(147.9) = 1.289$

$\dot{W}_{net} = \frac{W_{net} \cdot n}{n_{rev}} = \frac{1.289\,(2500)}{2\,(60)} \cdot \frac{1\,hp}{.7068} = 38.1\,hp$

4.6)



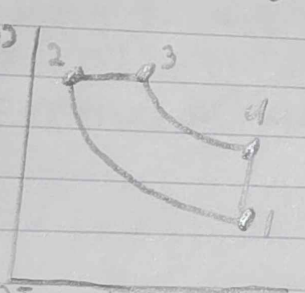
$R = .2870$ $C_p = 1.005$ $C_v = .718$ $k = 1.4$

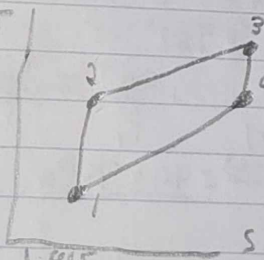
$T_2 = T_1\left(\frac{v_1}{v_2}\right)^{k-1} = 300K\,(16)^{1.4-1} = 909\,K$ $T_3 = 909 \cdot 2 = 1818$

$\eta_{Otto} = 1 - \frac{1}{r^{k-1}} = 1 - \frac{1}{2^{1.4-1}} = 24\%$ $\eta_{diesel} = 1 - \frac{1}{r^{k-1}}\frac{r_c^k - 1}{k(r_c - 1)} = 1 - \frac{1}{2^{1.4-1}}\frac{2^{1.4} - 1}{1.4(2-1)} = 37\%$

$MEP = \frac{w_{net}}{v_{max} - v_{min}} = 676\,kPa$

5.3)





$v_1 = \frac{RT_1}{P_1} = \frac{.287 \cdot 343}{97} = 1.015$ $v_2 = \frac{v_1}{r} = \frac{1.015}{22} = .04613$ $s_2 = s_1$

$T_2 = T_1\left(\frac{v_1}{v_2}\right)^{k-1} = 343 \cdot 22^{.4} = 1181\,K$ $P_2 = \frac{RT_2}{v_2} = \frac{.287 \cdot 1181}{.04613} = 7348\,kPa$

$w = C_v(T_1 - T_2) = .718(343 - 1181) = -601.7$ $P_3 = P_2 = 7348\,kPa$

$v_3 = v_c v_2 = 1.8(.04613) = .08303$ $T_3 = \frac{P_3 v_3}{R} = \frac{7348 \cdot .08303}{.287} = 2126\,K$

$Q = w + C_v(T_3 - T_2)$ $w = 7348(.08303 - .04613) = 271.1$

$Q = 271.1 + .718(2126 - 1181) = 949.7$ $v_4 = v_1 = 1015$ $s_4 = s_3$

$T_4 = T_3\left(\frac{v_3}{v_4}\right)^{k-1} = 2126\left(\frac{.08303}{1.015}\right)^{.4} = 781$ $w = C_v(T_3 - T_4) = .718(2126 - 781) = 965.7$

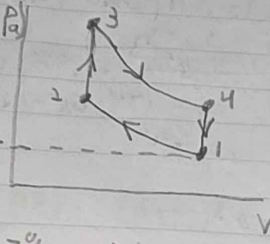
$Q = C_v(T_1 - T_4) = .718(343 - 781) = -314.5$ $m = \frac{V}{v} = \frac{2.44}{1.015 \cdot 1000} = 2.369 \cdot 10^{-3}$

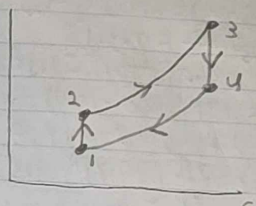
$W_{net} = m\,w_{net} = -601.7 + 271.1 + 965.7 + 0 = 635.1$ $W_{net} = 2.369 \cdot 10^{-3} \cdot 635.1 = 1.501$

$\dot{W}_{net} = \frac{W_{net} \cdot n}{n_{rev}} = \frac{1.501 \cdot 3500\,min/rev}{1\,rev/cycle} = 87.58\,kW$

Daniel Martinez MET 350 HW 1.3

33)





$T = 27°C + 273K = 300K$ per table A-17 $u = 214.07$ $v_{r_1} = 621.2$

$\frac{v_{r_2}}{v_{r_1}} = \frac{v_2}{v_1} = \frac{1}{r} \rightarrow v_{r_2} = \frac{v_{r_1}}{r} = \frac{621.2}{8} = 77.65 \rightarrow T_2 = 673.09$ $u_2 = 491.22$

$\frac{P_2 v_2}{T_2} = \frac{P_1 v_1}{T_1} \rightarrow P_2 = P_1 \left(\frac{T_2}{T_1}\right)\left(\frac{v_1}{v_2}\right) = 95 kPa \left(\frac{673.09 K}{300 K}\right) 8 = 1705.16 kPa$

$q_{in} = u_3 - u_2 \Rightarrow 750 kJ/kg = u_3 - 491.22 = 1241.22 kJ/kg \rightarrow T_3 = 1538.7 K$

$v_{r_3} = 6.55$ $\frac{P_3 v_3}{T_3} = \frac{P_2 v_2}{T_2} \rightarrow P_3 = P_2 \frac{T_3}{T_2}\left(\frac{v_2}{v_3}\right) = 1705.16 \left(\frac{1538.7}{673.09}\right)(1) = 3898 kPa$

$\frac{v_{r_4}}{v_{r_3}} = \frac{v_4}{v_3} = r \rightarrow v_{r_4} = r v_{r_3} = 8(6.55) = 52.4 \rightarrow T_4 = 776.1 K$ $u_4 = 572.98 kJ/kg$

$-q_{out} = u_1 - u_4 \rightarrow q_{out} = u_4 - u_1 = 572.98 - 214.07 = 358$

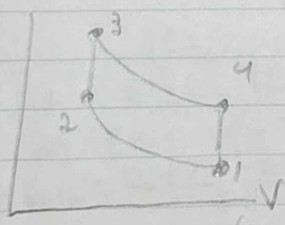
$w_{net} = q_{net} = q_{in} - q_{out} = 750 - 358 = 392 kJ/kg$

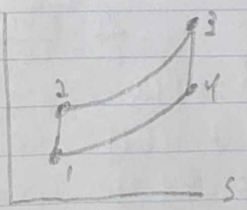
$\eta_{th} = \frac{w_{net}}{q_{in}} = \frac{392}{750} = 52.3\%$

$MEP = \frac{w_{out}}{v_1 - v_2} = \frac{w_{net}}{v_1(1 - 1/r)}$ $v_1 = \frac{RT_1}{P_1} = \frac{.287 \cdot 300}{95} = .906 m^3/kg$

$MEP = \frac{392}{.906\left(1 - \frac{1}{8}\right)} \frac{kJ}{m^3} = 495 kPa$

36)





$P_1 = 14 psia$ $T_1 = 105 F$

$= 565 R$

$T_3 = 2400 F + 460 = 2860 R$

$D = 3.5 in \cdot \frac{1 ft}{12 in} = .2917 ft$

$S = 3.9/12 = .325 ft$ $V_{min} = .098 V_{max}$

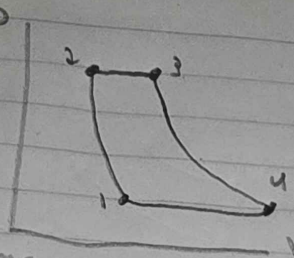
$v_1 = \frac{RT_1}{P_1} = \frac{.3704(565)}{14} = 14.95 \frac{ft^3}{lbm}$ $v_2 = .098 v_1 = .098 \cdot 14.95 = 1.465 \frac{ft^3}{lbm}$

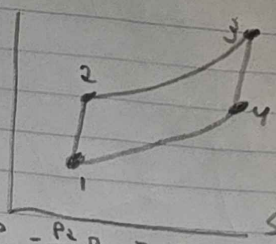
$s_2 = s_1$ $T_2 = T_1 \left(\frac{v_1}{v_2}\right)^{k-1} = 565 \left(\frac{14.95}{1.465}\right)^{0.4} = 1431 R$

$P_2 = \frac{RT_2}{v_2} = \frac{.3704(1431)}{1.465} = 361.7 psia$ $q_2 - w_2 = m(u_2 - u_1) = m C_v (T_2 - T_1) \Rightarrow w = C_v (T_1 - T_2)$

$w_2 = (.171)(565 - 1431) = -148.1$ $v_3 = v_2 = 1.465$ $T_3 = 2860 R$

80)





$T_1 = 520\,R$ $h_1 = 124.27$ $P_{R1} = 1.2147$ $P_{R2} = \frac{P_2}{P_1} P_{R1} = 10 \cdot 1.2147 = 12.147$

$T_2 = 995\,R$ $h_2 = 239.33$ $T_3 = 2000\,R$ $h_3 = 504.71$ $P_{R3} = 174$

$P_{R4} = \frac{P_4}{P_3} P_{R3} = \frac{1}{10} 174 = 17.4$ $T_4 = 1100\,K$ $h_4 = 266$

$w_{comp\,in} = h_2 - h_1 = 239.33 - 124.27 = 115.06$

$w_{turb\,out} = h_3 - h_4 = 504.71 - 266 = 238.71$ $r = \frac{w_{comp}}{w_{turb}} = \frac{115.06}{238.71} = .482$ or 48.2%

$q_{in} = h_3 - h_2 = 504.71 - 239.33 = 265.38$

$w_{net} = w_{out} - w_{in} = 238.71 - 115.06 = 123.65$

$\eta_{th} = w_{net} / q_{in} = 123.65 / 265.38 = .466$ or 46.6%