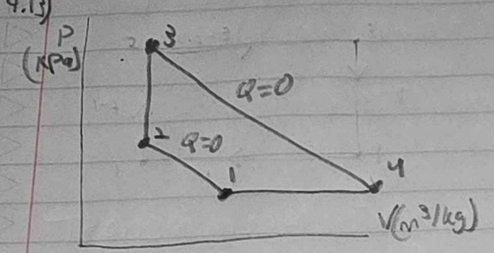
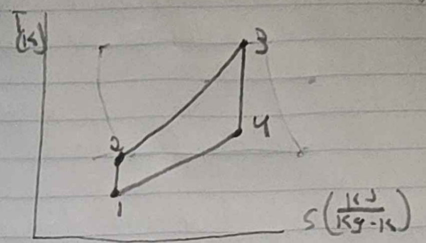
Daniel Martinez HW 1.2 MET 350

9.13)





$\eta_{th} = \frac{w_{net}}{q_{in}}$ $PV = RT$ $v_1 = \frac{RT_1}{P_1} = \frac{.287 \cdot 295}{100} = .8466 \frac{m^3}{kg}$

$u = 210.49 \frac{kJ}{kg}$ $s_1^0 = 1.68515 \frac{kJ}{kg \cdot K}$ $s_2 - s_1 = s_2^0 - s_1^0 - R \ln \frac{P_2}{P_1}$ $s_2 = s_1$

$s_2^0 = 1.68515 + .287 \ln \frac{600}{100} = 2.1994 \frac{kJ}{kg \cdot K}$ $T_2 = 490$ $u_2 = 352.08$ $P_2 = 600$

$v_2 = \frac{RT_2}{P_2} = \frac{.287 \cdot 490}{600} = .2344 \frac{m^3}{kg} = v_3$ $P_3 = \frac{RT_3}{v_3} = \frac{.287 \cdot 1500}{.2344} = 1837\ kPa$

$u_3 = 1205.41$ $s_3^0 = 3.44516$ $s_3 - s_2 = s_3^0 - s_2^0 - R \ln\left(\frac{P_3}{P_2}\right) = 3.44516 - 2.19938 - .287 \ln\left(\frac{1837}{600}\right)$

$= .9247$ $P_4 = P_1 = 100\ kPa$ $s_4 - s_3 = s_4^0 - s_3^0 - R \ln \frac{P_4}{P_3}$ $s_4 = s_3$ $s_4^0 = 3.441516 + .287 \ln \frac{100}{1837} = 2.6061$

$T_4 = 720K$ $u_4 = 528.14$ $v_4 = \frac{.287 \cdot 720}{100} = 2.066$

9.18) $PV = RT$ $T_1 = 1200K$ $T_4 = 350K$ $P_{R_1} = 238\ kPa$ $P_{R_4} = 2.379$

$P_1 = (P_{R_2} / P_{R_4}) P_4$ $P_1 = (238/2.379)\ 300 = 30013\ kPa \approx 30\ MPa$

$\eta_{th} = 1 - \frac{T_L}{T_H} = 1 - \left(\frac{350}{1200}\right) = 0.7084$ $Q_{in} = \frac{W_{net}}{\eta_{th}} = \frac{.5}{.7084} = .706kJ$

$s_4 - s_3 = s_4^0 - s_3^0 - R \ln(P_4/P_3)$

$s_4 - s_3 = -(0.287) \ln(300/150) = -.1989 = s_1 - s_2$ $s_2 - s_1 = .1989$

$W_{net\ out} = (s_2 - s_1)(T_H - T_L) = .1989 (1200 - 350) = 169.065$

mass $m = W_{net\ out} / w_{net\ out} = 0.5 / 169.065 = .00296\ kg$

9.13 cont) $w_2 = 210.49 - 352.08 = -141.6$ $q_{2-3} = 1205.4 - 352.08 = 853.3$

$w_{3-4} = 1205.4 - 528.14 = 677.3$ $w_4 = 100\ (.8466 - 2.066) = -121.9$

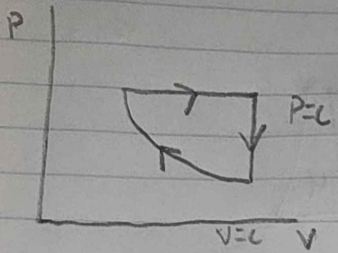
$w_{4-1} = w_4 + (u_1 - u_4) = -121.9 + (210.49 - 528.14) = -439.6$

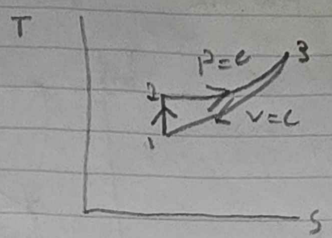
$w_{net} = -141.6 + 0 + 677.3 + -121.9 = 413.8 \frac{kJ}{kg}$

$\eta_{th} = 413.8 / 853.3 = .4849$

On a *T-s* diagram, a *heat-addition* process proceeds in the dire… increasing entropy, a *heat-rejection* process proceeds in the direc… decreasing entropy, and an *isentropic* (internally reversible, adiaba… cess proceeds at constant entropy. The area under the process curve… diagram represents the heat transfer for that process. The area under… …on a *T-s* diagram is a geometric measure of th… …and the area under the h…

4.22)





$c_p = R + c_v = 1$

$\frac{T_2}{T_1} = (r_c)^{k-1}$

$T_2 = (5)^{0.4} \cdot (20 + 273)$

$T_2 = 557.77 K$

$T_1 = 293 K$ $\quad W_{1-2} = C_v(T_2 - T_1) = .7(557.77 - 293) = 185.339$

for isentropic process $Q_{1-2} = 0$

$\frac{V_2}{T_2} = \frac{V_3}{T_3} \Rightarrow \frac{T_3}{T_2} = \frac{V_1}{V_2}$ $\quad T_3 = 5 \cdot 557.77 = 2788.85$

$Q_{2-3} = h_3 - h_2 = C_p(T_3 - T_2) = 1(2788.85 - 557.77) = 2231.08$

$W_{3-1} = 0$ $\quad Q_{3-1} = U_{3-1} = C_v(T_3 - T_1) = .7(2788.86 - 293) = 1747.102$

$W_{2-3} = 664.317$

$\eta_{th} = 48.8\%$

$\eta = \frac{W_{net}}{Q_s} = \frac{Q_s - Q_R}{Q_s}$ $\quad 1 - \frac{Q_R}{Q_S} \Rightarrow 1 - \frac{C_v\, T_3 - T_1}{C_p\, T_3 - T_2} \Rightarrow 1 - \frac{\cancel{T_3}\; 1 - T_1/T_3}{\gamma \cdot \cancel{T_3}\; 1 - T_2/T_3} \Rightarrow 1 - \frac{1 - T_1/T_3}{\gamma(1 - T_2/T_3)}$

$1 - \left(\frac{(1 - T_1/T_3)\, r_c}{(1 - \cancel{T_2}/\cancel{T_3})\, r_c}\right) \Rightarrow 1 - \frac{1 - 1/r_c^{\gamma-1} \cdot r_c}{\gamma\; 1 - 1/r_c} \Rightarrow \eta = \left(1 - \frac{1 - 1/r_c^{\gamma}}{\gamma(1 - 1/r_c)}\right) \cdot 100$

4.31 compression ratio $= 10.5$ $\quad$ power output $= 90 kW$

$\eta = 1 - \left(\frac{1}{r^{k-1}}\right)$ $\quad k = 1.4$ table A-2 $\quad \eta = \left(1 - \frac{1}{10.5^{(1.4-1)}}\right) \cdot 100 = 60.96\%$

$\eta = W/Q_{in} \Rightarrow Q_{in} = 90 kW / .6096 = 147.64 kW$