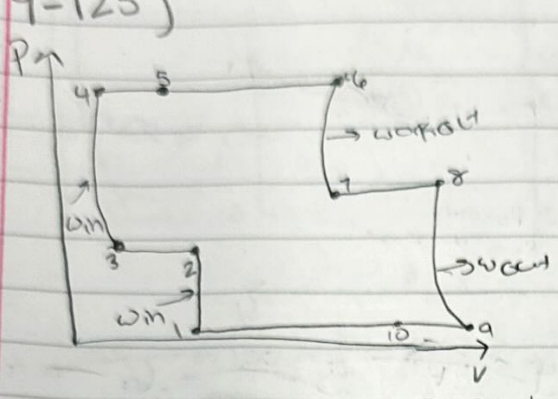
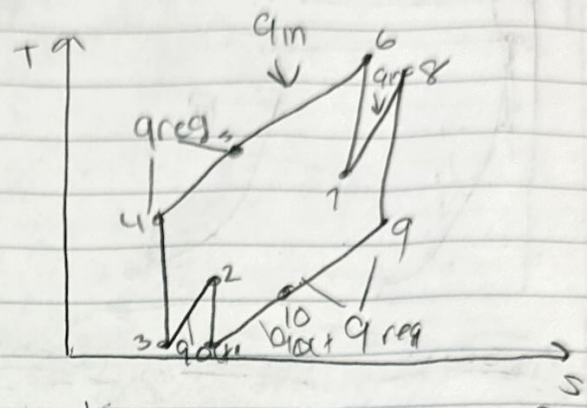
HW 1.5

$r_p = 4$ $C_p = 1.005$ $C_v = 0.718 \frac{kJ}{kg}$ $k = 1.4$

9-123)





1 — isent — 2 — P constant — 3 — isen — 4 — P constant regenerator — 5 — P const q_{in}

$P_1 = 100 kPa$

$T_1 = 290.15 K$

$v_1 = \frac{RT_1}{P_1} = 0.833 \frac{m^3}{kg}$

$P_2 = r_p P_1$

$P_2 = 400$

$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}}$

$T_2 = 431.16 K$

$v_2 = \frac{RT_2}{P_2} = 0.3 \frac{m^3}{kg}$

$P_3 = P_2$

$T_3 = T_1$

$v_3 = \frac{RT_3}{P_3} = 0.21 m^3/kg$

$P_4 = r_p P_3$

$P_4 = 1600$

$\frac{T_4}{T_3} = \left(\frac{P_4}{P_3}\right)^{\frac{k-1}{k}}$

$= 431.08 K$

$v_4 = \frac{RT_4}{P_4} = 0.077 \frac{m^3}{kg}$

$P_5 = P_4$

$T_5 = T_4 + 20$

$T_5 = 451.08 K$

$v_5 = 0.08 m^3/kg$

6 — isent — 7 — P constant q_{in} — 8 — isent — 9 — P const regenerat — 10 — P const

$P_6 = P_5$

$q_{in} C_p (T_6 - T_5)$

$q_{in} = 300 kJ/kg$

$T_6 = T_5 + \frac{q_{in}}{C_p}$

$T_6 = 749.61 K$

$v_6 = 0.134 \frac{m^3}{kg}$

$P_7 = P_6 / r_p$

$P_7 = 400 kPa$

$T_7 = \left(\frac{P_7}{P_6}\right)^{\frac{k-1}{k}} T_7$

$T_7 = 504.55$

$v_7 = \frac{RT_7}{P_7}$

$= 0.362 \frac{m^3}{kg}$

$P_8 = P_7$

$T_8 = T_7 + \frac{q_{in}}{C_p}$

$T_8 = 803.68 K$

$v_8 = 0.576$

$P_9 = P_{10}$

$P_9 = 100 kPa$

$\frac{T_9}{T_8} = \left(\frac{P_9}{P_8}\right)^{\frac{k-1}{k}}$

$= 546.51$

$v_9 = 1.551 m^3/kg$

$P_{10} = P_1$

$T_{10} = T_9 - \frac{(T_5 - T_4)}{20}$

$T_{10} = 520.51 K$

$v_{10} = 1.414 \frac{m^3}{kg}$

$\eta_{th} = \frac{w_{net}}{q_{in}}$

$w_{net} = w_{out} + w_{out} - w_{in} - w_{in}$
$8-9 \quad 6-7 \quad 1-2 \quad 3-4$

$w_{net} = 226.801 kJ/kg$

$q_{in} = q_{in} + q_{in} = 300 kJ/kg + 300$
$5-6$

~~$q_{in} = 600 kJ/kg$~~

$\eta_{th} = 0.378$

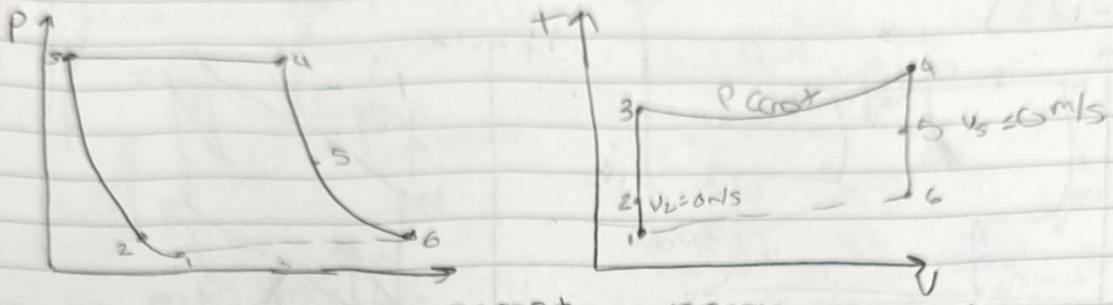
$w_{out} = h_6 - h_7 = C_p (T_6 - T_7) = 246.267 kJ/kg$

$w_{out} = h_8 - h_9 = C_p (T_8 - T_9) = 263.863 kJ/kg$

$w_{in} = h_2 - h_1 = C_p (T_2 - T_1) = 141.705 kJ/kg$

$w_{in} = h_4 - h_3 = C_p (T_4 - T_3) = 141.624 kJ/kg$

9-129) $r_p = 13$ $C_p = 0.24$ Btu/lbm $C_v = 0.171$ Btu/lbm
$k = 1.41$



1 Isent 2 Isent 3 P const 4 Isent 5 Isent 6

$P_1 = 7$ psia $V_2 = 0$ ft/s $P_3 = r_p P_2$ $T_4 = 2400$R $V_5 = 0$ m/s $P_6 = P_1$

$T_1 = 469.67$R $T_2 = T_1 + \frac{V_1^2}{2 C_p}$ $= 13(7.27)$ $= 94.5$ psia $P_4 = P_3$ $T_5 = T_4 + (T_3 - T_2)$ $\frac{T_6}{T_5} = \left(\frac{P_6}{P_5}\right)^{\frac{k-1}{k}}$

$V_1 = 900$ ft/s $T_2 = 537.4$R $V_4 = 1.75$ $T_5 = 1819.08$R $T_6 = 1,008$

$V_1 = \frac{RT_1}{P_1} = \frac{0.069(469.67)}{(7)}$ $\frac{P_2}{P_1} = \left(\frac{T_2}{T_1}\right)^{\frac{k}{k-1}}$ $\frac{T_3}{T_2} = \left(\frac{P_3}{P_2}\right)^{\frac{k-1}{k}}$ $\frac{P_5}{P_4} = \left(\frac{T_5}{T_4}\right)^{\frac{k}{k-1}}$

$= 4.62$ $T_3 = 1118.32$R $= 87.31$ psia $V_6 = \sqrt{2 C_p (T_5 - T_6)}$

$P_2 = 7.27$ psia $V_3 = \frac{RT_3}{P_3}$ $V_6 = 3000$ ft/s

$V_2 = \frac{RT_2}{P_2}$ $= 0816$ $V_5 = 1.44$

$= 5.10$

(a) 537.4R Pressure at exit

(b) 3,000 ft/s velocity exhaust gases

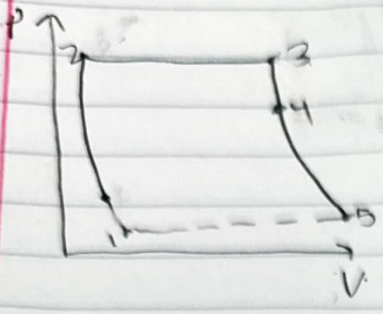
(c)

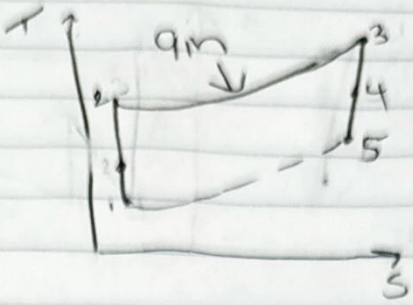
$w_{in} = C_p(T_4 - T_3) = 307.68$ $C_p(T_6 - T_1) = 129.20$

$w_{in} = 178.48$ Btu/lbm

$\eta_p = \frac{178.48}{307.68} = 0.58$ or 58%

9-135) $r_p = 9$





1 — isen — 2 — isen — 3 — P const — 4 — isen — 5 — P const

$P_1 = 95\,kPa$ $P_2 = P_{r1} r_p$ $h_3 = h_2 + \frac{0.5}{2.5}(1420\,kJ/kg)$ $h_4 = h_3 + h_2 - h_1$ $P_{r5} = \frac{P_{r3}}{9}$

$T_1 = 280\,K$ $P_2 = 9.8001$ $h_3 = 1562.28$ $h_4 = 1347.63 + 284.07$ $P_{r5} = 60.4$

$v_1 = 0.845\,m^3/kg$ $h_2 = 525.38$ $T_3 = 1464.35\,K$ $h_4 = 1631.7\,kJ/kg$ $h_5 = 877.410$

$h_1 = 280.13\,kJ/kg$ $T_2 = 521.64$ $P_{r3} = 541.4$ $T_4 = 1260\,K$ $T_5 = 850.2\,K$

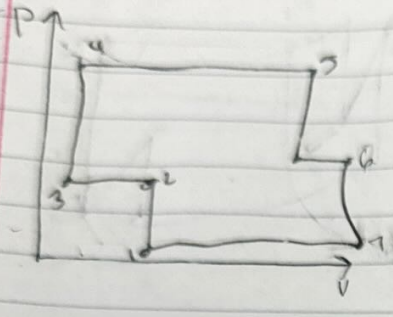
$P_{r1} = 1.0889$

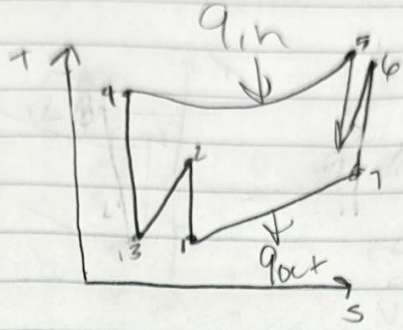
$V_e = \sqrt{2(h_4 - h_5)} = 969.6\,m/s$

$F = \dot{m} V_e = 20(969.6) = 19392\,N$

$\dot{m}$

9-167)





1 isen — 2 P const — 3 P const — 4 isen — 5 P const — 6 isen — 7

$P_1 = 100 kPa$

$v_1 = \frac{RT_1}{P_1}$

$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}}$

$P_2 = P_1 rp$

$P_3 = P_2$

$T_3 = T_1$

$\frac{T_4}{T_3}\left(\frac{P_4}{P_3}\right)^{\frac{k-1}{k}}$ $P_5 = P_4$ $\frac{T_5}{T_4} = \left(\frac{P_5}{P_4}\right)^{\frac{k-1}{k}}$

$P_4 = rp P_3$

$P_6 = P_5$ $\frac{T_7}{T_6} = \left(\frac{P_7}{P_6}\right)^{\frac{k}{}}$

$P_7 = P_1$

$q_{in} = h_4 - h_5 = C_p(T_4 - T_5)$

$q_{out} = h_6 - h_1 = C_p(T_6 - T_1)$

$w_{net} = w_{out} - w_{in}$

$w_{out} = C_p(T_5 - T_6)$

$w_{in} = C_p(T_2 - T_1)$

$\eta_{th} = \frac{w_{net}}{q_{in}}$