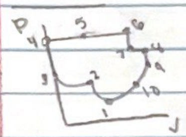
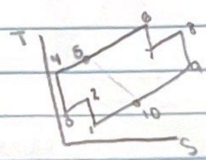
HW 1.5 - MET 350 - KAYLA DAVIES

## 9-123





$r_p = 4$

| ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | ⑨ | ⑩ |
|---|---|---|---|---|---|---|---|---|---|
| $T_1 = 290\,K$ | $T_2 = T_1\left(\frac{P_2}{P_1}\right)^{\frac{r-1}{r}}$ | $T_3 = 290\,K$ | $T_4 = T_3(P_r)$ | $T_5 = 451\,K$ | $T_6 = 750\,K$ | $T_7 = T_5$ | | $T_5 = T_9$ | $T_{10} = T_4$ |
| $P_1 = 100\,kPa$ | $T_2 = 431\,K$ | $P_3 = P_2$ | $T_4 = 431\,K$ | | $T_6 = T_8$ | | | | |
| | $P_2 = 400\,kPa$ | | | | | | | | |

(② – ③: CP; ④ – ⑤: CP)

$Q_{in} = Cp(T_6 - T_5) + Cp(T_8 - T_7) \therefore 2Cp(T_6 - T_7)$

$Q_{out} = Cp(T_{10} - T_1) + Cp(T_2 - T_3) \therefore 2Cp(T_2 - T_1)$

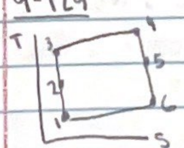
$W_{net} = 2Cp \times (T_6 - T_7) - (T_2 - T_1)$

$\eta_{TH} = \frac{W_{net}}{Q_{in}} = 1 - \frac{T_2 - T_1}{T_6 - T_7}$

$= 1 - \frac{T_1}{T_6}\left(\frac{P_2}{P_1}\right)^{r-1/r}$

$= 1 - [290/750](4)^{\frac{1.4-1}{1.4}} = 0.425$ or $\boxed{42.5\%}$

## 9-129



$r_p = 13$

| ① | ② | ③ | ④ | ⑤ | ⑥ |
|---|---|---|---|---|---|
| $T_1 = 470\,R$ | $T_2 = 537.4\,R$ | $P_3 = 145.5\,Psia$ | $T_4 = 2400$ | $P_5 = 55.2\,Psia$ | $T_6 = 1008.4\,R$ |
| $V_1 = 900$ | $P_2 = 11.19$ | $T_3 = 1118.3\,R$ | | $T_5 = 1819.1$ | |

(① – ②: diffuser; ② – ③: comp.; ④ – ⑤: T; ⑤ – ⑥: nozzle)

$h_1 + \frac{V_1^2}{2} = h_2 + \frac{V_2^2}{2} \therefore 0 = h_2 - h_1 + \frac{V_2^2 - V_1^2}{2} = Cp(T_2 - T_1) + \frac{V_2^2 - V_1^2}{2}$

$T_2 = T_1 - \left(\frac{V_2^2 - V_1^2}{2Cp}\right) \therefore 470 + \frac{900^2}{2 \times 0.24} - \frac{1}{25037} = 537.4\,R$

$P_2 = P_1(T_2/T_1)^{.4/1.4} = 7(537.4/470) = 11.19\,Psia$

$P_3 = P_4 = r_p * P_2 = 13 \times 11.19 = 145.5\,Psia$

$T_3 = 537.4\left[\frac{145.5}{11.19}\right]^{\frac{1.4-1}{1.4}} = 1118.3\,R \qquad T_6 = 1819.1\left(\frac{7}{55.2}\right)^{\frac{1.4-1}{1.4}} = 1008.4\,R$

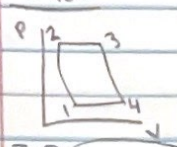
a) $P_5 = 145.5\left[\frac{1819.1}{2400}\right]^{\frac{1.4}{1.4-1}} = \boxed{55.2\,Psia}$

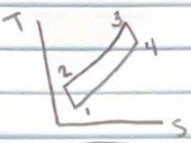
$h_5 + \frac{V_5^2}{2} = h_6 + \frac{V_6^2}{2} \therefore 0 = Cp(T_6 - T_5) - \frac{V_6^2 - V_5^2}{2}$

b) $V_6^2 = 2Cp(T_5 - T_6) \qquad V_6 = \sqrt{2(0.24)(1819.1 - 1008.4)(25037/1)} = \boxed{3121\,ft/s}$

c) $\eta_p = \frac{2}{(V_6/V_1) + 1} = \frac{2}{(3121/900) + 1} = 0.448$ or $\boxed{44.8\%}$

9-135




$r_p = 9 \qquad m_p = 0.5$

$m = 20\ kg/s$

$HV = 42700$

(1) — (2) — (3) — (4)

$T_1 = 280\ K \qquad P_{r_2} = 9 \times 1.0889 \qquad h_4 = h_3 - h_2 + h_1$

$P_1 = 95\ kPa \qquad P_{r_2} = 9.8 \qquad h_4 = 1347.63$

$h_1 = 280.13 \qquad h_2 = 525.387$

$P_{r_1} = 1.0889$

$Q_{in} = m_f \times HV = 0.5 \times 42700 = 21350$

$q_{in} = Q_{in}/m = 21350/20 = 1067.5$

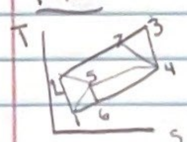
$P_{r5} = P_{r3}\left(\frac{1}{r_p}\right) \therefore 543.83\left(\frac{1}{9}\right) = 60.425$

$h_4 + \frac{1}{2}v_{in}^2 = h_5 + \frac{1}{2}v_{out}^2 \qquad h_5 = 877.5003$

$v_{out} = \sqrt{2(h_4 - h_5)} = \sqrt{2(1347.63 - 877.5003) \times 1000} = 969.66\ m/s$

$F = m(v_{out} - v_{in}) = 20(969.66 - 0) = \boxed{19393.2\ N}$

9-167




$1 \xrightarrow{isen} 2 \xrightarrow{cp} 3 \xrightarrow{isen} 4 \xrightarrow{cp} 5 \xrightarrow{isen} 6 \longrightarrow 7$

$T_5 = T_2 = T_1\left(P_2/P_1\right)^{\frac{k-1}{k}} \qquad * P_2/P_1 = r_p$

$T_7 = T_4 = T_3\left(P_4/P_3\right)^{\frac{k-1}{k}} \therefore T_3\left(\frac{1}{\sqrt{r_p}}\right)^{\frac{k-1}{k}} = T_3 r_p^{\frac{1-k}{2k}}$

$T_6 = T_5\left(P_6/P_5\right)^{\frac{k-1}{k}} \therefore T_5\left(\frac{1}{\sqrt{r_p}}\right)^{\frac{k-1}{k}}$

$Q_{in} = C_p(T_3 - T_7) = C_p T_3 (1 - r_p)^{\frac{1-k}{2k}}$

$Q_{out} = C_p(T_6 - T_1) = C_p T_1\left(r_p^{\frac{k-1}{k}} - 1\right)$

$\eta_{TH} = \frac{Q_{out}}{Q_{in}} = \boxed{1 - \frac{T_1}{T_3} r_p^{\frac{k-1}{k}}}$

THE STANDARD CYCLE HAS A LOWER $\eta_{TH}$ THAN REGENERATION & EXPANSION.