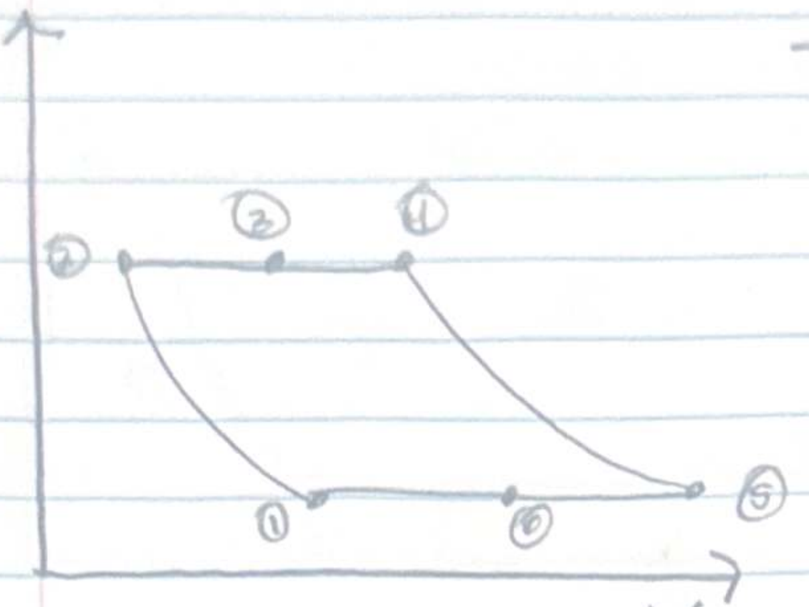
Test #1

$C_p = 1.005$ $R = .287$ $\eta_L = 0.8$

1. P



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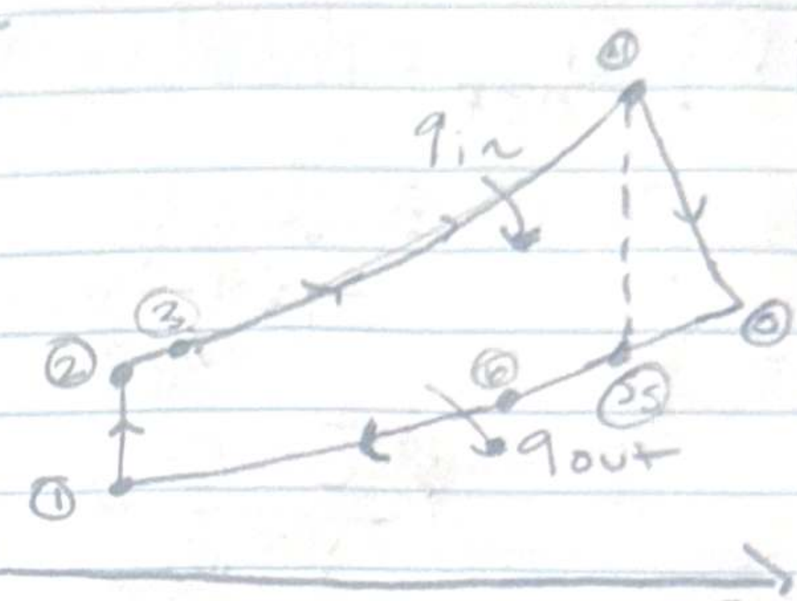


$W_{net} = 500kJ$

$K = 1.4$

1 Isentropic comp → 2 P const → 3 P const (q_{in}) → 4 Isent Turb → 5 → 6 P const → 1

$P_1 = 100kPa$	$P_2 = 500kPa$	$P_3 = 500kPa$	$P_4 = 500kPa$	$P_5 = 400kPa$
$T_1 = 310K$	$T_2 = 490.97$	$T_3 = 760K$	$T_4 = 1140K$	$T_5 = 803.8$
$v_1 = .889$	$v_2 = .281$	$v_3 = .436$	$v_4 = .654$	$v_5 = 2.06$

1 bar = 100kPa

$r_p = \frac{P_2}{P_1} = 5$

$\frac{K-1}{K} = \frac{1.4-1}{1.4} = .2857$

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

$T_2 = (T_1)(r_p)^{\frac{K-1}{K}}$

$T_2 = (310)(5)^{.2857}$

$q_{in}_{3-4} = C_p(T_4 - T_3)$

$= 1.005(1140 - 760)$

$q_{in}_{3-4} = 381.9$

$T_{s_5} = T_4\left(\frac{P_{s_5}}{P_4}\right)^{\frac{K-1}{K}}$

$= 1140\left(\frac{1}{5}\right)^{.2857} = T_{s_5}$

$T_{s_5} = 719.7$

$\eta_{th_T} = 0.8$

$0.8 = \frac{T_4 - T_5}{T_4 - T_{s_5}}$

$T_5 = 803.8$

A) $\eta_{th} = \frac{W_{net}}{q_{in}}$

$\epsilon = \frac{T_5 - T_2}{T_4 - T_2}$

$337.8 - 181.8$

$\epsilon = \frac{312.9}{649.03} = 0.48$

$W_{net} = C_p(T_4 - T_5) - C_p(T_2 - T_1)$

$= 156$

$\epsilon = 48\%$

$\eta_{th} = \frac{156}{381.9} = \boxed{\eta_{th} = .408} \rightarrow 41\%$

#1 cont'd

B) $\dot{W}_{net} = \dot{m}(W_{net})$

$\rightarrow \dot{m} = \dfrac{\dot{W}_{net}}{W_{net}}$

$= \dfrac{500}{156}$

$\boxed{\dot{m} = 3.2 \text{ kg/s}}$

c) @ 100% η

$T_3 = T_5$

$W_t = C_p(T_4 - T_5) \rightarrow 337.881$

$W_c = C_p(T_2 - T_1) \rightarrow 181.87$

$q_{in} = C_p(T_4 - T_3) \rightarrow 337.881$

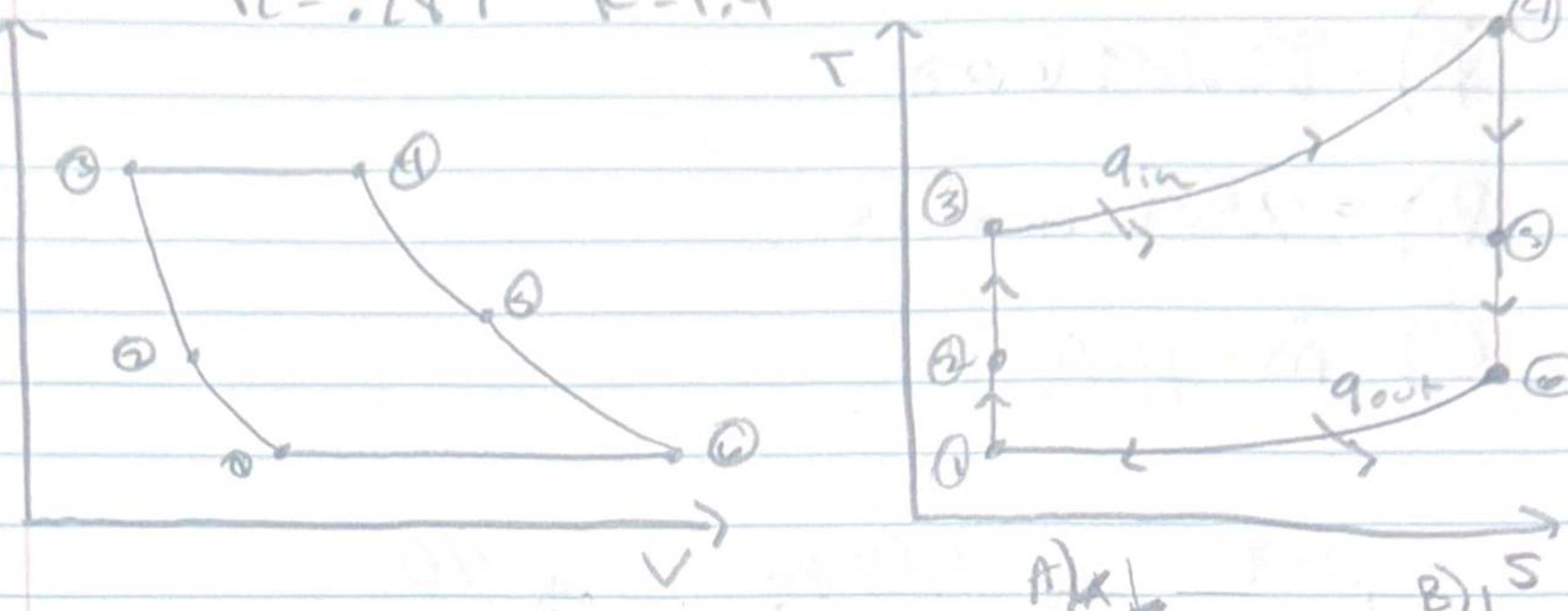
$W_{net} = W_t - W_c \rightarrow 156.011$

$\eta = \dfrac{156.011}{337.881} \rightarrow .461 \rightarrow 46\%$

$C_p = 1.005$ $C_v = .718$

#2 $V_1 = 250 m/s$ $W_c = 500 kJ/kg$ $\eta_c = 0.8$ $\eta_t = 0.9$

$R = .287$ $k = 1.4$



$r_p = \frac{P_2}{P_1}$

$r_p = 1.5$

$\frac{1.4}{1.4-1} = 3.5$

① Isent ② Isent comp ③ P const ④ Isent Turb ⑤ Isent noz ⑥ P const

				A	
$P_1 = 40 kpa$	$P_2 = 61.4$	$P_3 = 92.1$	$P_4 = 92.1$	$P_5 = 83.69$	$P_6 = 40 kpa$
$T_1 = 238K$	$T_2 = 269$	$T_3 = 302$	$T_4 = 1223K$	$T_5 = 1190$	$T_6 = 963.7$
$V_1 = 250 m/s$					$V_6 = 257.6 m/s$

$-35°C + 273 = 238K$

$950°C + 273 = 1223$

$1 km/h = \frac{1000m}{3600s} = \frac{5}{18} m/s$

$900(\frac{5}{18}) = 250 m/s$

$T_2 = \frac{V_1^2}{2C_p} + T_1$

$\frac{250^2}{2(1005)} + 238K$

$T_2 = 269$

$P_3 = P_4$

$P_3 = (r_p)(P_2)$

$1.5(61.4)$

B

$V_6 = \sqrt{2C_p(T_4 - T_5)}$

$V_6 = \sqrt{2(1005)(T_4 - T_5)}$

$= 257.6 m/s$

$T_5 = T_4 - T_3 + T_2$

$= 1223 - 302 + 269$

$T_5 = 1190$

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

$P_2 = 40\left(\frac{269}{238}\right)^{3.5}$

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

$T_3 = T_2\left(\frac{P_3}{P_2}\right)^{k-1/k}$

$= 269\left(\frac{92.1}{61.4}\right)^{.2857}$

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

#2 cont'd

A) = 83.69 kpa

B) = 257.6 m/s

C) $\dot{m} = \rho_0 \cdot A_0 \cdot V_0$

$\rho_0 = \frac{P_0}{RT_0} \rightarrow \frac{40 kpa}{(.287)(238k)} \rightarrow \frac{40}{68.306} =$

$\rho_0 = .585$

$A_0 = \pi \cdot \left(\frac{D_0}{2}\right)^2$

$A_0 = \pi \left(\frac{1.6}{2}\right)^2$

$A_0 = 2.01$

$V_0 = 250 m/s$

$\dot{m} = (.585)(2.01)(250)$

$\dot{m} = 293.9$

$F = \dot{m}(V_6 - V_0)$

$= 293.9(287.6 - 280)$

$F = 2233.64 N$