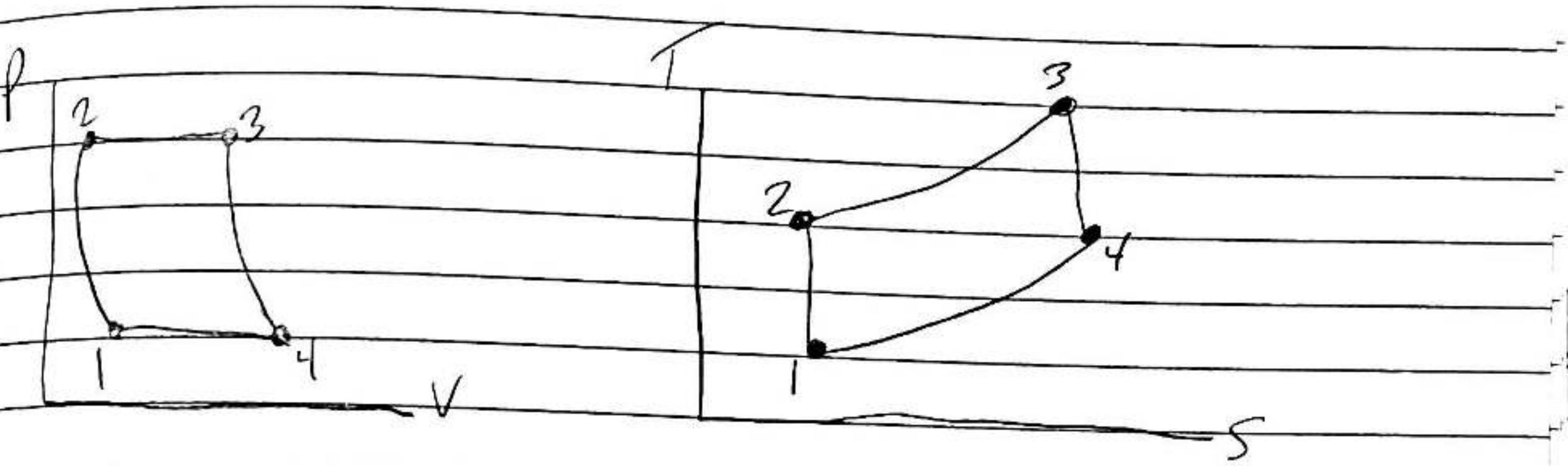
ROY SHEPARD MET 331 H/W 1.4 88, 99, 107, 119, 121

Problem 88



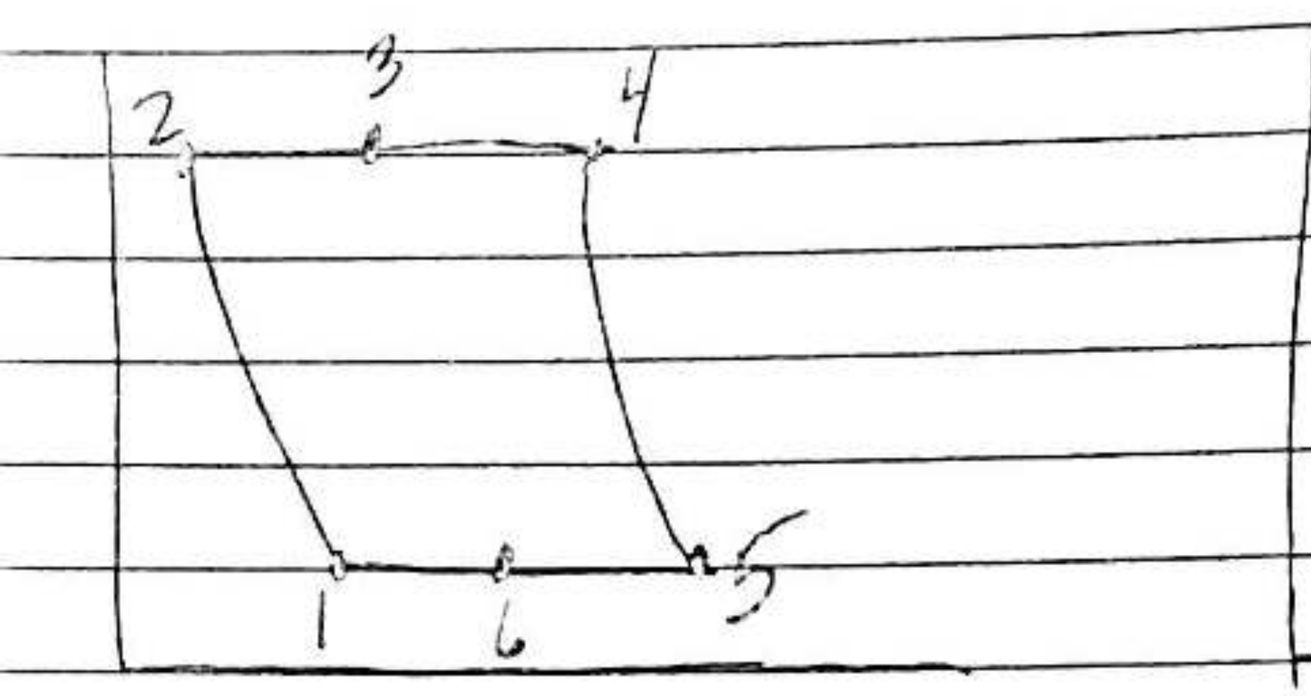
$r = 10$

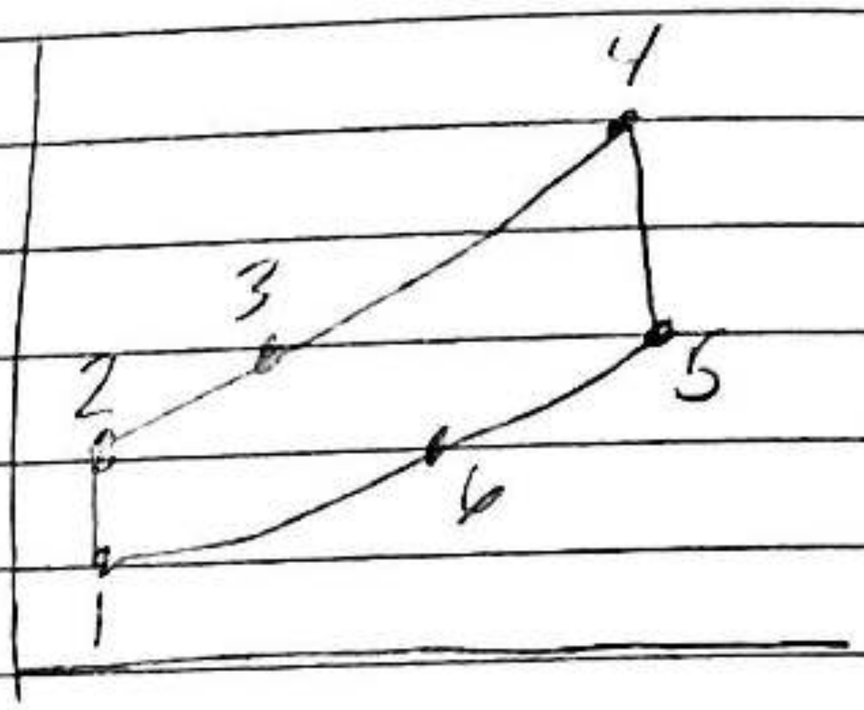
$Q_{IN} = 500 kW$

$$\eta = 1 - r_p^{(k-1)/k} = 1 - 10^{(1.4-1)/1.4} = \boxed{0.482}$$

$$W = \eta Q_{IN} = 0.482 \cdot 500 = \boxed{241 kW}$$

Problem 99





(1) $P_1 = 100kPA$ $\quad \frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{k-1}$ $\quad T_2 = 303(10)^{\frac{0.4}{1.4}} = 585K$

$T_1 = 303K$

(2) $P_2 = 1000kPA$

$T_2 = 585K$

(3) $P_3 = 1000kPA$ $\quad T_2 = T_5 - 10 = 556 - 10 = 546K$

$T_3 = 546K$

(4) $P_4 = 1000kPa$ $\quad \frac{T_4}{T_5} = \left(\frac{P_4}{P_5}\right)^{\frac{k-1}{k}} = 1073\left(\frac{1}{10}\right)^{\frac{0.4}{1.4}} = 556K$

$T_4 = 1073K$

(5) $P_5 = 100kPa$

$T_5 = 556K$

(6) $P_6 = 100kPa$ $\quad T_6 = T_5 - (T_3 - T_2) = 556 - (546 - 585)$

$T_6 = 595K$ $\quad = 595K$

$$\dot{m} = \frac{\dot{W}}{w} \leq \frac{\dot{W}}{h_3 - h_4 - (h_2 - h_1)}$$

$$= \frac{\dot{W}}{c_p\left(T_3 - T_2 r_p^{-(k-1)/k} - T_1 r_p^{(k-1)/k} + T_1\right)}$$

$$\leq \frac{\dot{W}}{c_p\left(T_3\left(1 - r_p^{-(k-1)/k}\right) + T_1\left(1 - r_p^{(k-1)/k}\right)\right)}$$

$$\frac{115}{1.005\left(1073\left(1 - 10^{-(1.4-1)/1.4}\right) + 303\left(1 - 10^{(1.4-1)/1.4}\right)\right)}$$

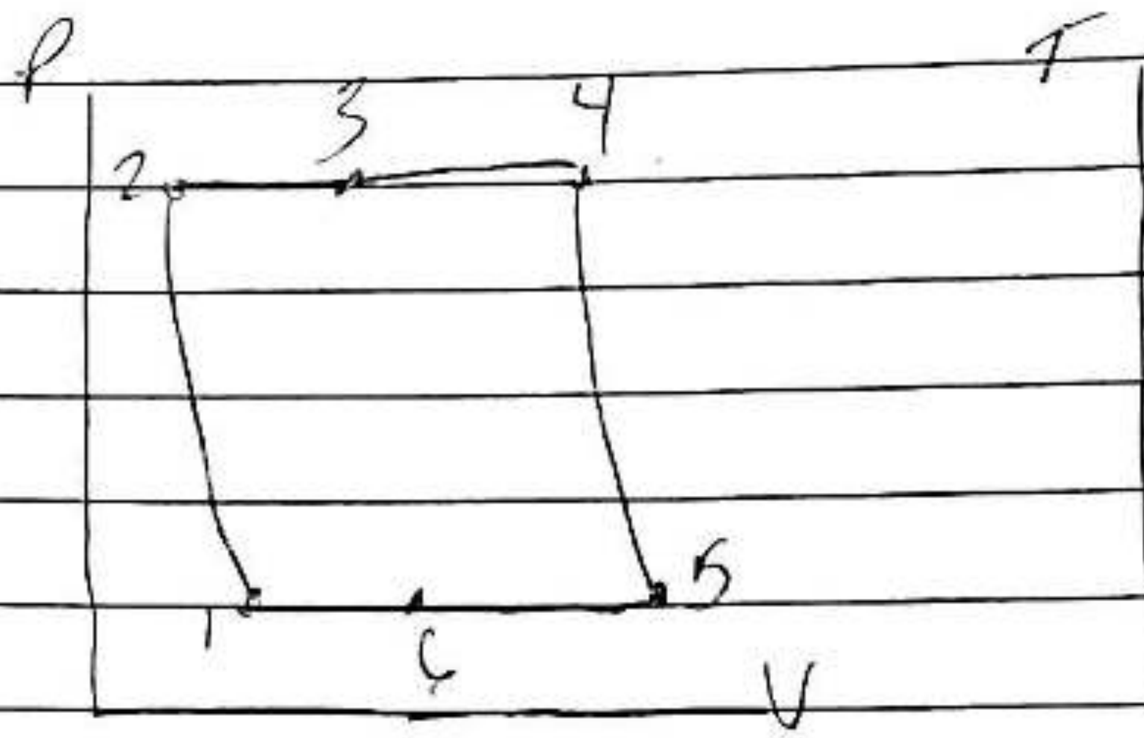
$$= 0.486 \text{ kg/s}$$

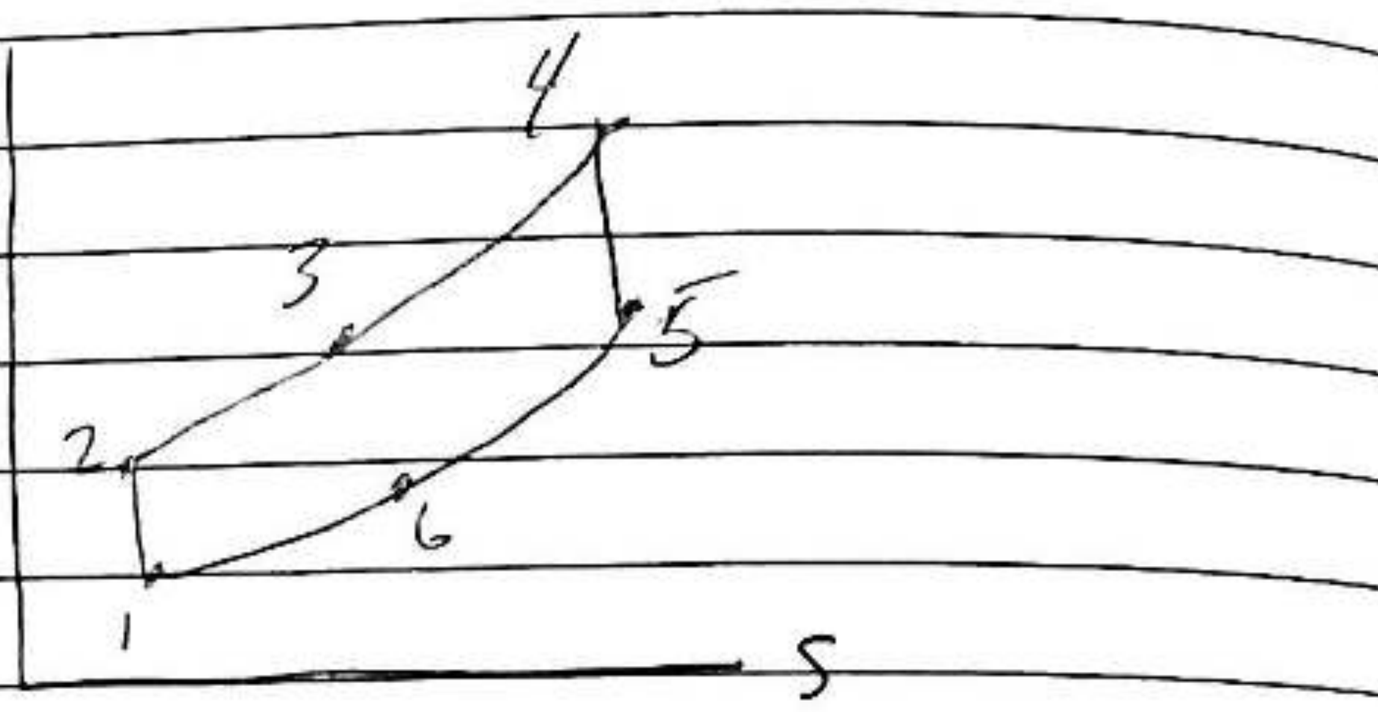
$$Q_{out} = \dot{m}\left(T_c - T_1\right) = 0.486 \cdot 1.005\left(595 - 303\right)$$

$$= \boxed{143 \text{ kW}}$$

$$Q_{IN} = \dot{W} + Q_{out} = 115 + 143 = \boxed{258 \text{ kW}}$$

Problem 107





(1) P_1 100 kPa
T_1 310 K
h_1 310.24
$P_{r_1} = 1.555$

(2) $P_2 = 700$ kPa $\quad P_{r_2} = P_{r_1} \cdot P_{r_1} = 7 \cdot 1.555 = 10.885$
$T_2 = 612$ K $\quad h_{2s} = 541.3$
$h_2 = 618.3$ $\quad h_2 = 310.24 + (541.3 - 310.24)/.75 = 618.3$
$Pr_2 = 17.4$

(3) $P_2 = 700$ kPa $\quad h_3 = 618.3 + .65(803 - 618)$
$T_2 = 724$ K $\quad h_3 = 738.4$
$h_3 = 738.4$

(4) $P_4 = 700$ kPa
$T_4 = 1150$ K
$h_4 = 1219.3$
$P_{r_4} = 200$

(5) $P_6 = 100$ kPa $\quad P_{r_5} = \frac{1}{P_r} \cdot P_{r_4} = P_{r_2} = \frac{1}{7} \cdot 200 = 28.6$
$T_6 = 783$ K $\quad h_{5s} = 712$
$h_5 = 803.3$ $\quad h_5 = 1219 - .52(1219 - 712) = 803.3$

(6) $P_6 = 100$ kPa

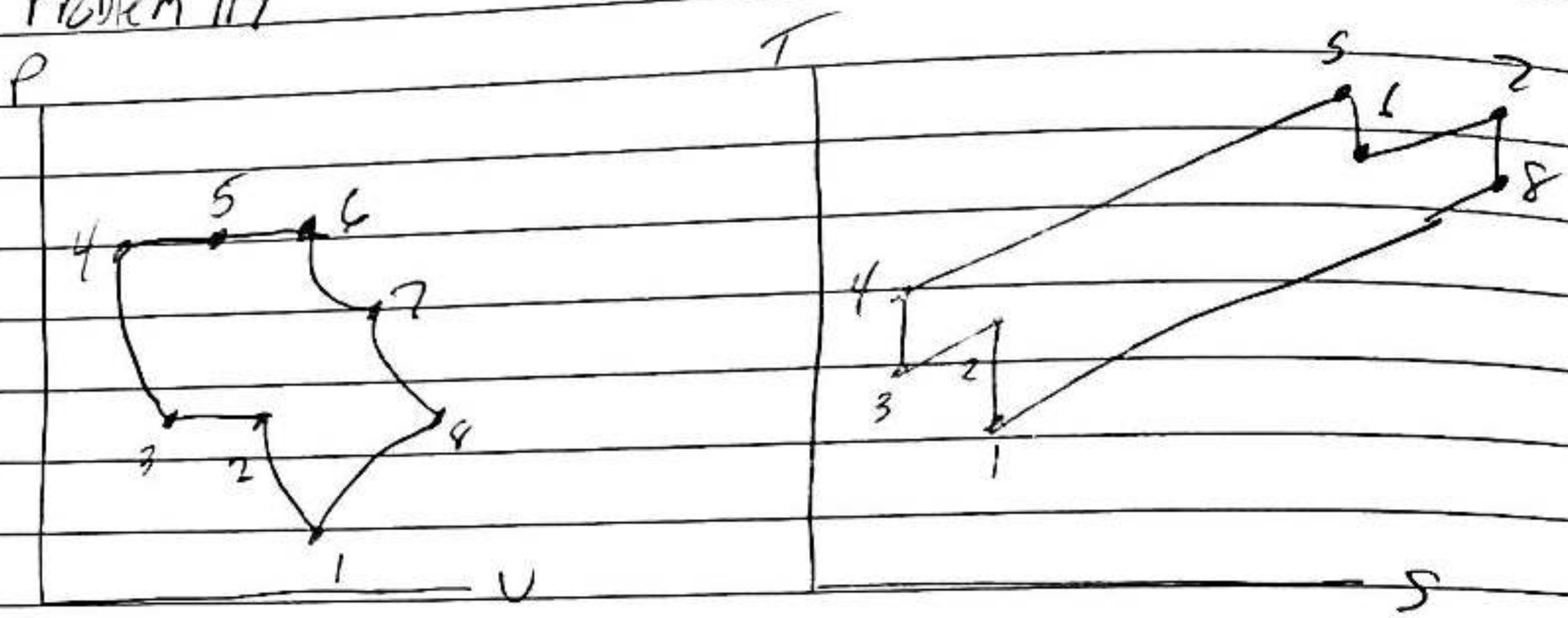
$T_3 = 783\ K$ (a)

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

$= (1219 - 803) - (618.3 - 310) = 108\ kJ/kg$ (b)

$\eta_{th} = \frac{w_{net}}{h_2 - h_3} = \frac{108}{480.8} = 0.225 = 22.5\%$ (c)

Problem 119



① $P_r = 100 kPa$

$T_1 = 300K$

$h_1 = 300$

$P_{r_1} = 1.386$

② $T_2 = 410K$ $\quad P_{r_2} = (P_r)(P_{r_1}) = (3)(1.386) = 4.158$

$h_2 = 411.3$

$P_{r_2} = 4.158$

③ $T_3 = 300K$

$h_3 = 300$

④ $T_4 = 410K$

$h_4 = 411.3$

⑤ $T_5 = 1200K$

$h_5 = 1278K$

$P_{r_5} = 238$

⑥ $T_6 = 910K$ $\quad P_{r_6} = (P_r)(P_{r_5}) = \left(\frac{1}{3}\right)(238) = 79.3$

$h_6 = 946.4$

$P_{r_6} = 79.3$

⑦ $T_7 = 1200K$

$h_7 = 1278$

⑧ $T_8 = 910K$

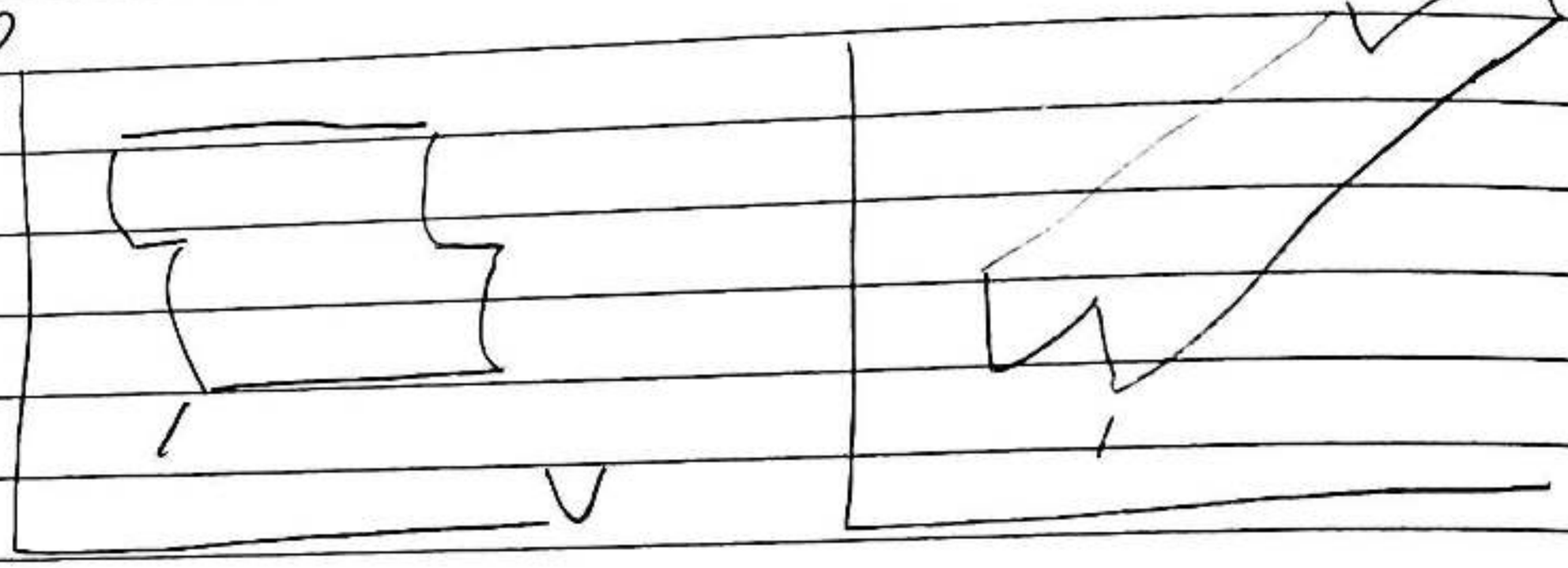
$w_{in} = 2(h_2 - h_1) = 2(411 - 300) = 222$

$w_{out} = 2(h_5 - h_6) = 2(127 - 94.5) = 65.3$

$w_{net} = 65.3 - 22.2 = 44.1$

$\dot{m} \frac{w}{w_{net}} = \frac{110,000}{44.1} = 2504 g/s$

Problem 121



① $h_1 = 300.19 \frac{kJ}{kg}$

$P_{r1} = 1.386$

② $P_{r2} = 4.158$

$h_2 = 411.26 \text{ kJ/kg}$

$P_{r2} = \frac{P_2}{P_1} P_{r1} = 3.138(1.386) = 4.158$

③ $h_3 = 300.19 \text{ kJ/kg}$

$P_{r3} = 1.386$

④ $h_4 = 411.26 \text{ kJ/kg}$

⑤

⑥ $P_{r6} = 238$

$h_6 = 1277.79 \text{ kJ/kg}$

⑦ $P_{r7} = 79.33$

$h_7 = 946.35 \text{ kJ/kg}$

$P_{r7} = \frac{P_7}{P_6} P_{r6} = \frac{238}{3} = 79.$

⑧ $P_{r8} = 238$

$h_8 = 1272.5 \text{ kJ/kg}$

⑨ $h_9 = 946.35 \text{ kJ/kg}$

(a)

$$(bw = \frac{W_C}{W_t} = \frac{2(h_2 - h_1)}{2(h_6 - h_7)} = \frac{411.26 - 3cal?}{1277.79 - 946.35}$$

$$= 0.335$$

$$\eta = \frac{W}{q_{in}} = \frac{2(h_6 - h_7) - 2(h_2 - h_1)}{h_6 - h_4 + h_8 - h_7}$$

$$\frac{2(1277.79 - 946.35) - 2(411.26 - 3cal?)}{1277.25 - 411.26 + 1277.79 - 946.35}$$

$$= 0.368$$

(b) $$\eta = \frac{W}{q_{IN} - q_{rej}}$$

$$\frac{2(h_6 - h_7) - 2(h_2 - h_1)}{h_6 - h_4 + h_8 - h_7 - \xi(h_5 - h_4)}$$

$$\frac{2(1277.79 - 946.35) - 2(411.26 - 30cal?)}{1277.79 - 411.26 + 1277.25 - 946.25 - 0.75(946.35 - 411.26)}$$

$$= 0.553$$