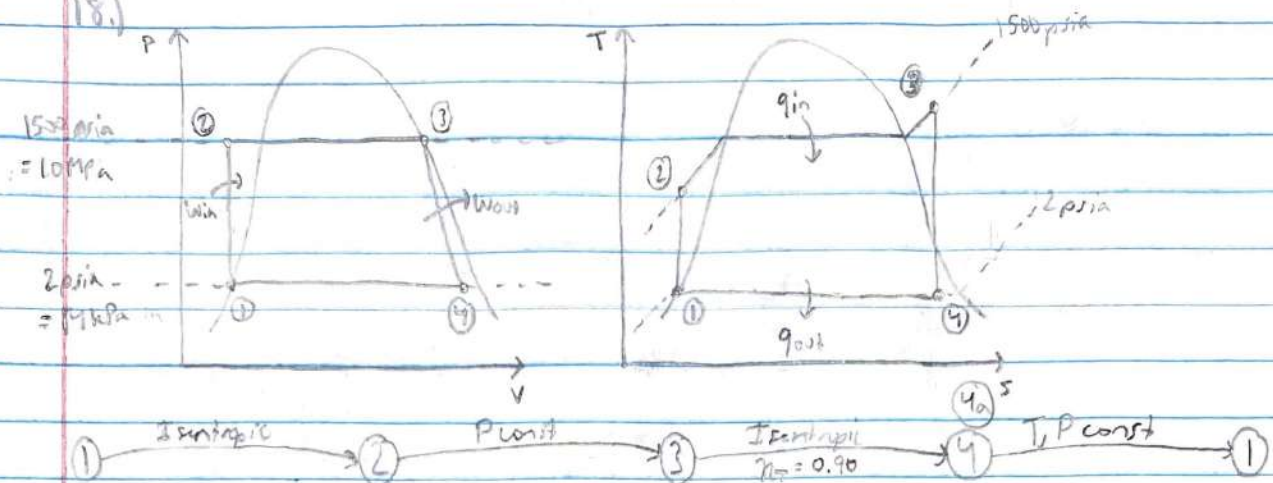


18.)



$P_1 = 14 \text{ kPa}$	$P_2 = 10 \text{ MPa}$	$P_3 = 10 \text{ MPa}$	$P_4 = 14 \text{ kPa}$
$T_1 = 52.34^\circ\text{C}$	$S_2 = 0.73 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}$	$T_3 = 800^\circ\text{F} = 426.7^\circ\text{C}$	$S_4 = 6.33 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}$
$h_1 = 219.11 \frac{\text{kJ}}{\text{kg}}$	$h_2 = 229.226 \frac{\text{kJ}}{\text{kg}}$	$h_3 = 3174.88 \frac{\text{kJ}}{\text{kg}}$	$T_4 = 52.34^\circ\text{C}$
$S_1 = 0.73 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}$		$S_2 = 6.33 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}$	$h_4 = 2071.74 \frac{\text{kJ}}{\text{kg}}$
$V_1 = 0.001013 \frac{\text{m}^3}{\text{kg}}$		$V_3 = 0.03 \frac{\text{m}^3}{\text{kg}}$	$x_4 = 0.767$

Find T_1, h_1, S_1, V_1 Find h_2 Find h_3, S_3

Interpolate $h_2 - h_1 = V_1(P_2 - P_1)$ Table A-6

from table A-5 $h_2 = 0.001013(10 \text{ MPa} - 14 \text{ kPa}) + h_1$ Interpolate

Find x_4

Find h_4

$$x_4 = \frac{S_4 - S_{f@52.34^\circ\text{C}}}{S_{fg@52.34^\circ\text{C}}}$$

$$h_4 = h_{f@52.34^\circ\text{C}} + x_4 h_{fg@52.34^\circ\text{C}}$$

$$S_{fg@52.34^\circ\text{C}}$$

$$h_4 = 219.13 + 0.767(2376.29)$$

$$x_4 = \frac{6.33 - 0.73}{7.30}$$

$$h_4 = 2071.74$$

$$7.30$$

$$x_4 = .767$$

$$P = 2500 \text{ kW}$$

$$q_{in} = h_3 - h_2 = 2945.65 \frac{\text{kJ}}{\text{kg}}$$

$$q_{out} = h_4 - h_1 = 1822.63 \frac{\text{kJ}}{\text{kg}}$$

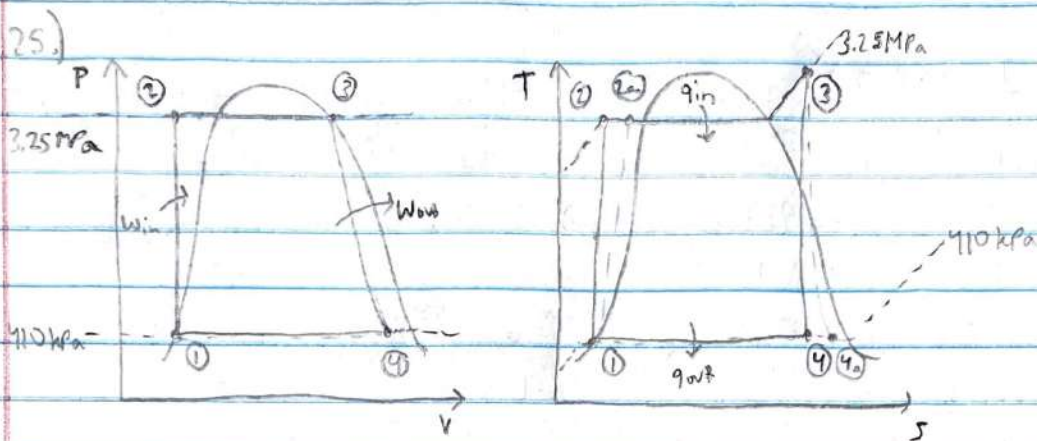
$$w_{net} = q_{in} - q_{out} = 1123.02 \frac{\text{kJ}}{\text{kg}}$$

$$a.) \dot{m} = \frac{P}{w_{net}} = \frac{2500}{1123.02} = 2.23 \text{ kg/s}$$

$$b.) P_T = \dot{W}_T = \dot{m}(h_3 - h_4) = 2.23(3174.88 - 2041.74) = 2526.9 \text{ kW}$$

$$c.) \dot{Q}_{in} = \dot{m}q_{in} = 2.23(2945.65) = 6568.8 \text{ kg/s}$$

$$d.) \eta = \frac{\dot{W}_{net}}{\dot{Q}_{in}} = \frac{1121.02}{2945.65} = 0.38 = 38\%$$



Isobaric Properties obtained from book. $C_p = 4.25 \text{ kJ/kg} \cdot ^\circ\text{C}$

①	Isobaric $\eta_p = 0.90$	②	P_{const}	③	Isentropic Turbine	④	P_{const}	①
$h_1 = 273.01 \frac{\text{kJ}}{\text{kg}}$		②a		$P_3 = 3.25 \text{ MPa}$		④a		
$V_1 = 0.001872 \frac{\text{m}^3}{\text{kg}}$		$P_2 = 3.25 \text{ MPa}$		$T_3 = 147^\circ\text{C}$		$P_4 = 110 \text{ kPa}$		
$P_1 = 110 \text{ kPa}$		$h_2 = 278.24 \frac{\text{kJ}}{\text{kg}}$		$\dot{m} = 305.6 \text{ kg/s}$		$T_4 = 79.5^\circ\text{C}$		
				$h_3 = 761.57 \frac{\text{kJ}}{\text{kg}}$		$h_4 = 689.77 \frac{\text{kJ}}{\text{kg}}$		
						$h_{4a} = 670.40 \frac{\text{kJ}}{\text{kg}}$		

Find h_2

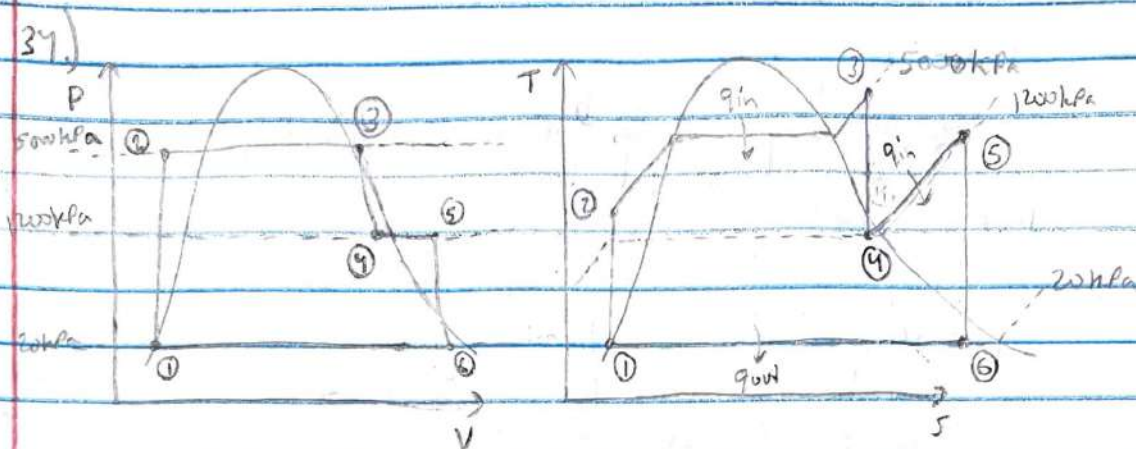
$$h_2 - h_1 = V_1(P_2 - P_1)$$

$$a.) \eta_T = \frac{h_3 - h_4}{h_3 - h_{4a}} = \frac{71.8}{91.14} = 0.79 = \boxed{79\%}$$

$$b.) \dot{W}_p = \dot{W}_{T, \text{out}} - \dot{W}_{p, \text{in}} = \dot{m}[(h_3 - h_4) - (h_2 - h_1)]$$

$$= 305.6(66.57) = \boxed{20343.79 \text{ kW}}$$

$$c.) \eta = \frac{\dot{W}_{net}}{\dot{Q}_{in}} = \frac{(h_3 - h_4) - (h_2 - h_1)}{(h_3 - h_2)} = \frac{66.57}{483.3} = 0.14 = \boxed{14\%}$$



1	Isentropic	2	P const	3	Isentropic	4	P const	5	Isentropic	6	P const	1
$P_1 = 20 \text{ kPa}$		$P_2 = 500 \text{ kPa}$		$P_3 = 500 \text{ kPa}$		$P_4 = 1200 \text{ kPa}$		$P_5 = 1200 \text{ kPa}$		$P_6 = 20 \text{ kPa}$		
$x = 0$		$h_2 = 251.48 \frac{\text{kJ}}{\text{kg}}$		$S_3 = 6.7495 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$		$x_4 = 0.96$		$S_5 = 7.6242 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$		$x_6 = 0.96$		
$T_1 = 60.06^\circ \text{C}$		$S_2 = 0.8320 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$		$T_3 = 328.77^\circ \text{C}$		$S_4 = 6.7495 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$		$T_5 = 481.06^\circ \text{C}$		$S_6 = 7.6242 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$		
$v_1 = 0.001017$				$h_3 = 3006.70 \frac{\text{kJ}}{\text{kg}}$		$h_4 = 2704.71 \frac{\text{kJ}}{\text{kg}}$		$h_5 = 3435.31 \frac{\text{kJ}}{\text{kg}}$		$h_6 = 2514.62 \frac{\text{kJ}}{\text{kg}}$		
$h_1 = 251.42 \frac{\text{kJ}}{\text{kg}}$												
$S_1 = 0.8320 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$												

Find h_2

$$h_2 - h_1 = v_1(P_2 - P_1)$$

Find S_4

$$S_4 = S_f @ 1200 \text{ kPa} + x_4 S_{fg} @ 1200 \text{ kPa}$$

$$S_4 = 6.7495$$

Find h_4

$$h_4 = h_f @ 1200 \text{ kPa} + x_4 h_{fg} @ 1200 \text{ kPa}$$

Find S_6

$$S_6 = S_f @ 20 \text{ kPa} + x_6 S_{fg} @ 20 \text{ kPa}$$

Find h_6

$$h_6 = h_f @ 20 \text{ kPa} + x_6 h_{fg} @ 20 \text{ kPa}$$

$$a.) T_3 = 328.77^\circ \text{C}$$

$$T_5 = 481.06^\circ \text{C}$$

$$b.) \eta = \frac{W_{net}}{q_{in}} = \frac{1217.53}{3480.8} = 0.35 = \boxed{35\%}$$

$$W_{net} = W_{out} + W_{out} - W_{in}$$

3-4 5-6 1-2

$$= (h_3 - h_4) + (h_5 - h_6) - (h_2 - h_1)$$

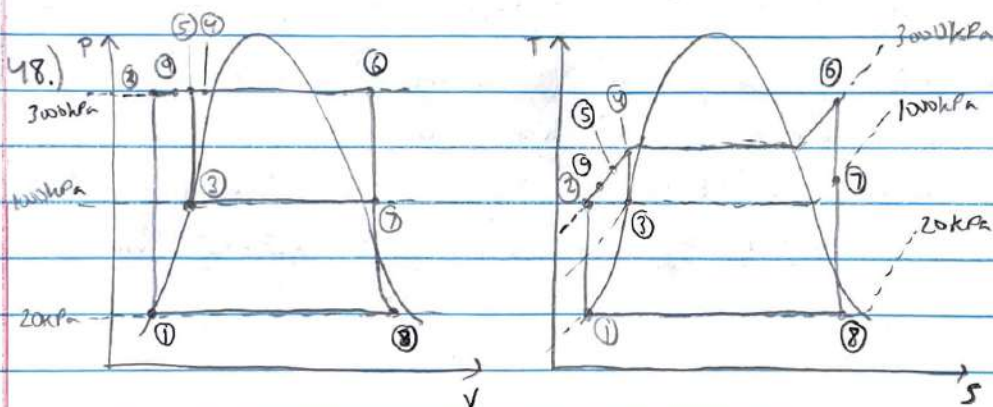
$$W_{net} = 302 + 920.54 - 5.06 = 1217.53 \text{ kJ/kg}$$

$$q_{in} = q_{in} + q_{in}$$

2-3 4-5

$$= (h_3 - h_2) + (h_5 - h_4)$$

$$= 2779.8 + 731 = 3480.8 \text{ kJ/kg}$$



See next page for states.



$$P_1 = 20 \text{ kPa}$$

$$T_1 = 60.06^\circ\text{C}$$

$$h_1 = 251.92 \frac{\text{kJ}}{\text{kg}}$$

$$s_1 = 0.8720 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}$$

$$\gamma_1 = 0.01017 \text{ m}^3/\text{kg}$$

$$P_2 = 1000 \text{ kPa}$$

$$h_2 = 252.12 \frac{\text{kJ}}{\text{kg}}$$

$$P_3 = P_7 = 1000 \text{ kPa}$$

$$P_4 = 200 \text{ kPa}$$

$$P_5 = 3000 \text{ kPa}$$

$$P_6 = 3000 \text{ kPa}$$

$$T_6 = 350^\circ\text{C}$$

$$h_6 = 3116.1 \frac{\text{kJ}}{\text{kg}}$$

$$s_6 = 6.7450 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}$$

$$P_7 = 1000 \text{ kPa}$$

$$P_8 = 20 \text{ kPa}$$

Find h_2

$$h_2 - h_1 = \gamma_1 (P_2 - P_1)$$