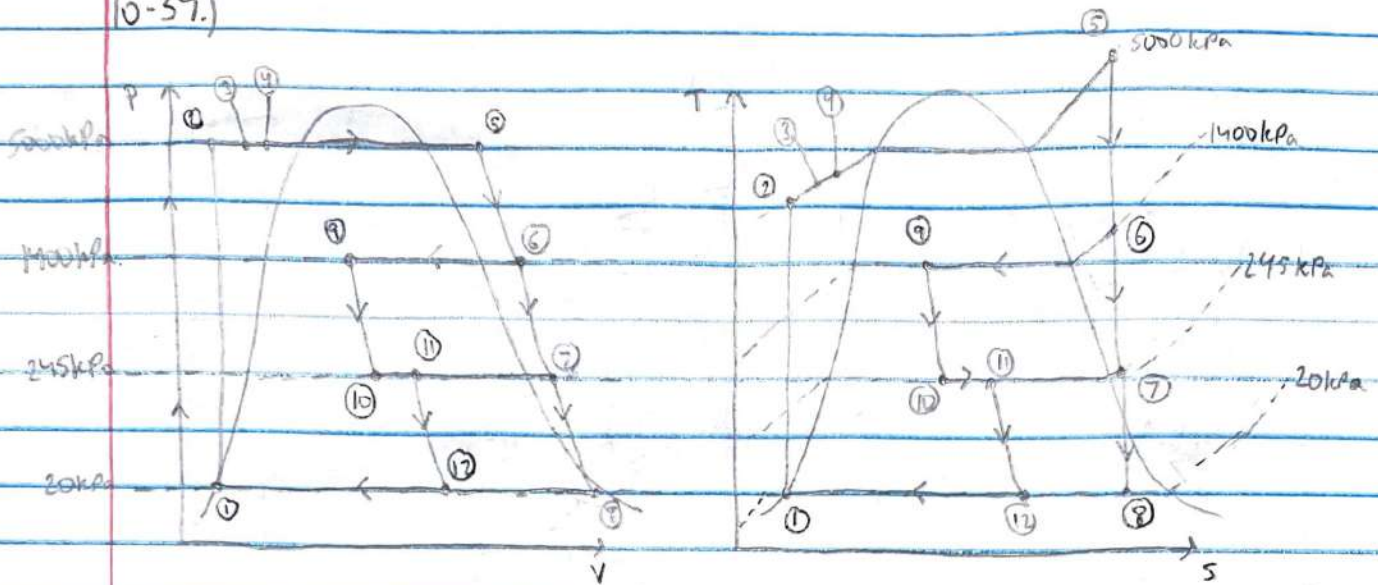


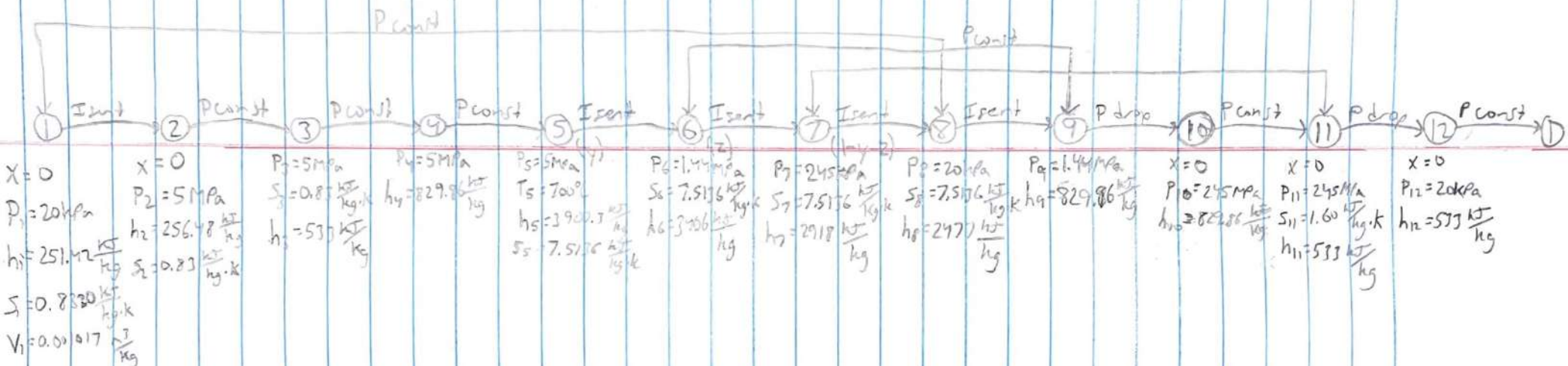
Cameron Sutter
10-57.)

HW 2.2



Given: $\gamma = 0.1496$

See next page for states.



Find h_2

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

$$h_2 = 256.48 \frac{\text{kJ}}{\text{kg}}$$

Find s_2

Interpolated using calculator

b) $m \times h_{in} = m \times h_{out}$

$$h_2 + z h_7 + y h_{10} = h_3 + z h_{11} + y h_{12}$$

$$z h_7 - z h_{11} = h_3 - h_2 - y h_{10} + y h_{12}$$

$$z = \frac{h_3 - h_2 - y(h_{10} - h_{12})}{h_7 - h_{11}}$$

$$z = \frac{533 - 256.48 - 0.1446(829.86 - 533)}{2918 - 533}$$

$$z = 0.0979$$

d) $W_{\text{net}} = \dot{m}(w_t - w_p)$

$$W_{\text{net}} = 92298.19 - 379.5$$

$$W_{\text{net}} = 91918.69 \text{ kW}$$

$$\eta = \frac{W_{\text{net}}}{Q_{\text{in}}} = \frac{91918.69}{230283} = 0.40 = 40\%$$

$$w_t = \dot{m}(h_5 - y h_6 - z h_7 - (1 - y - z) h_8)$$

$$w_t = 75[3900.3 - (0.1446)(3206) - (0.0979)(2918) - (1 - 0.1446 - 0.0979)(2477)]$$

$$w_t = 75(322.12 - 1891.48)$$

$$w_t = 92298.19 \text{ kW}$$

$$w_p = \dot{m}(h_2 - h_1)$$

$$w_p = 379.5 \text{ kW}$$

$$Q_{\text{in}} = \dot{m}(h_5 - h_4)$$

$$Q_{\text{in}} = 75(3900.3 - 829.86)$$

$$Q_{\text{in}} = 230283 \text{ kW}$$

c) $c_p = 4.18 \text{ kJ/kg}\cdot\text{K}$

$$Q_w = \dot{m} c_p \Delta T$$

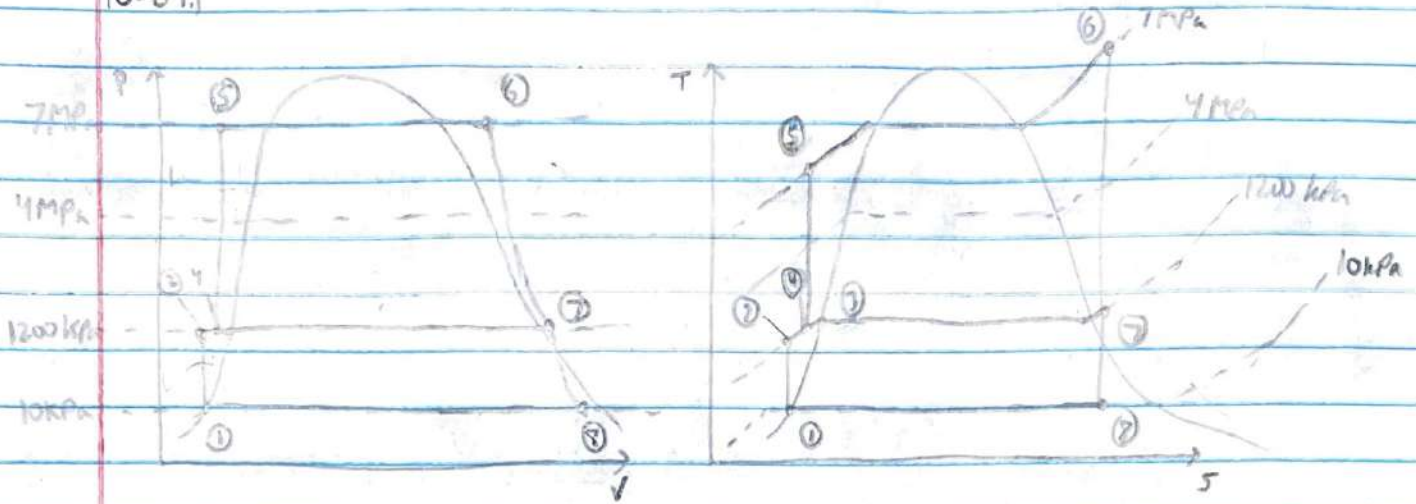
$$\dot{m} c_p \Delta T = \dot{m}[(y + z)h_{12} + (1 - y - z)h_8 - h_1]$$

$$\dot{m}(4.18)(10) = 75[(0.1446 + 0.0979)(533) + (1 - 0.1446 - 0.0979)(2477) - 251.42]$$

$$\dot{m}(4.18) = 75[1757.16]$$

$$\dot{m}_w = 3147.72 \text{ kg/s}$$

10-69.)



Given: $m_{\text{ball}} = 55 \text{ kg/s}$
 $y = \frac{1}{4}$

There is inconsistency with boiler pressure of 7 MPa and turbine pressure of 7 MPa. Assume they are equal at 7 MPa.

See next page for states.



$$P_1 = 10 \text{ kPa}$$

$$h_1 = 191.81 \text{ kJ/kg}$$

$$s_1 = 0.6472 \text{ kJ/kg}\cdot\text{K}$$

$$v_1 = 0.001010 \text{ m}^3/\text{kg}$$

$$x = 0$$

Find h_2

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

Find h_5

$$h_5 = v_4 (P_5 - P_4) / h_4$$

Find h_7

Interpolate

$$P_2 = 1200 \text{ kPa}$$

$$h_2 = 193.01 \text{ kJ/kg}$$

$$P_3 = 1200 \text{ kPa}$$

$$h_3 = 798.37 \text{ kJ/kg}$$

$$s_3 = 2.2159 \text{ kJ/kg}\cdot\text{K}$$

$$v_3 = 0.001158 \text{ m}^3/\text{kg}$$

$$P_4 = 1200 \text{ kPa}$$

$$h_4 = 344.34 \text{ kJ/kg}$$

$$v_4 = 0.001032 \text{ m}^3/\text{kg}$$

$$P_5 = 7 \text{ MPa}$$

$$h_5 = 350.726 \text{ kJ/kg}$$

$$P_6 = 7 \text{ MPa}$$

$$T_6 = 501.0^\circ\text{C}$$

$$h_6 = 3411.4 \text{ kJ/kg}$$

$$s_6 = 6.8 \text{ kJ/kg}\cdot\text{K}$$

$$P_7 = 1200 \text{ kPa}$$

$$s_7 = 6.8 \text{ kJ/kg}\cdot\text{K}$$

$$h_7 = 2920.04 \text{ kJ/kg}$$

$$P_8 = 10 \text{ kPa}$$

$$s_8 = 6.8 \text{ kJ/kg}\cdot\text{K}$$

$$h_8 = 2157.91 \text{ kJ/kg}$$

Find h_4

$$\dot{m}_4 h_4 = \dot{m}_1 h_1 + \dot{m}_3 h_3$$

$$55 h_4 = \left(\frac{3}{4} \cdot 55\right)(193.01) + \left(\frac{1}{4} \cdot 55\right)(798.37)$$

$$h_4 = 344.34 \text{ kJ/kg}$$

$$x_g = \frac{s_g - s_f}{s_{fg}}$$

$$x_f = \frac{6.8 - 0.6472}{7.4998}$$

$$x_g = 0.82 \text{ kJ/kg}\cdot\text{K}$$

Find h_8

$$h_g = h_f + x_g h_{fg}$$

$$= 191.81 + 0.82(2392.1)$$

$$= 2157.91 \text{ kJ/kg}$$

$$W_T = \dot{m}_6 (h_6 - h_7) + \dot{m}_8 (h_7 - h_8)$$

$$= 55(3411.4 - 2920.04) + 41.25(2920.04 - 2157.91)$$

$$W_T = 58644.16 \text{ kW}$$

$$W_{pin} = \dot{m}_1 w_{p1} + \dot{m}_3 w_{p3}$$

$$= 41.25(1200 - 10)(0.001010) + 13.75(1200 - 1200)(0.001010)$$

$$= 49.578375 + 82.202$$

$$W_{pin} = 131.78 \text{ kW}$$

$$a.) W_{net} = W_T - W_{pin}$$

$$= 58644.16 - 131.78$$

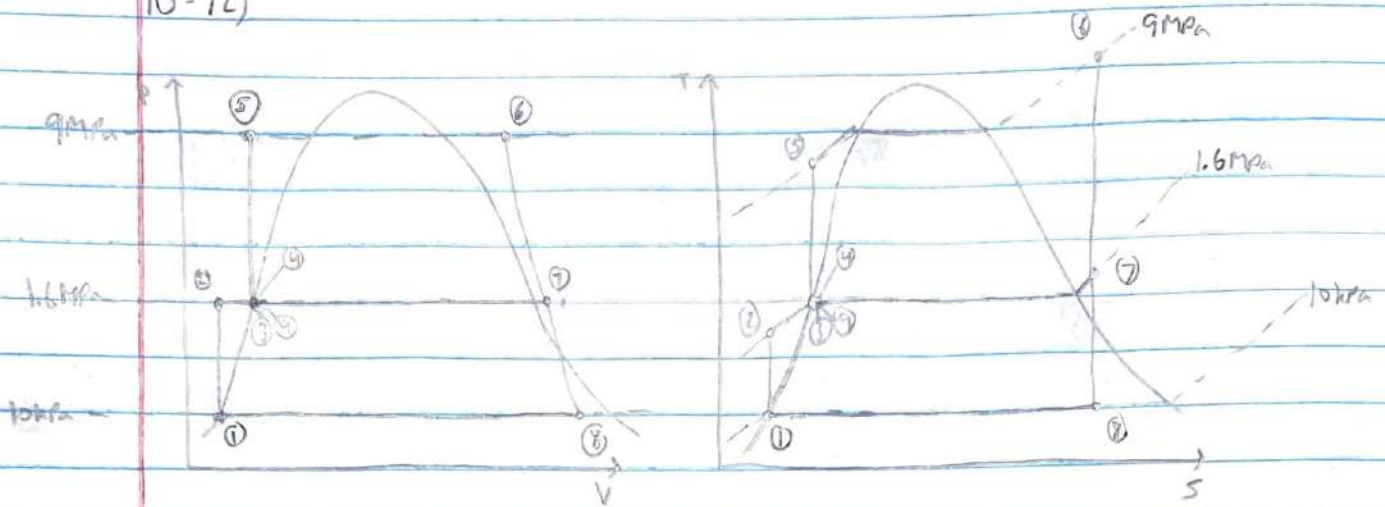
$$W_{net} = 58512.28 \text{ kW}$$

$$\begin{aligned}
 b.) \quad Q_{\text{power}} &= \dot{m}_7 (h_7 - h_3) \\
 &= 13.75 (2920.07 - 78.77) \\
 &= 29173.513 \text{ kW}
 \end{aligned}$$

$$\begin{aligned}
 Q_{\text{in}} &= \dot{m}_8 (h_8 - h_5) \\
 &= 55 (3411.4 - 2920.07) \\
 &= 27027.8 \text{ kW}
 \end{aligned}$$

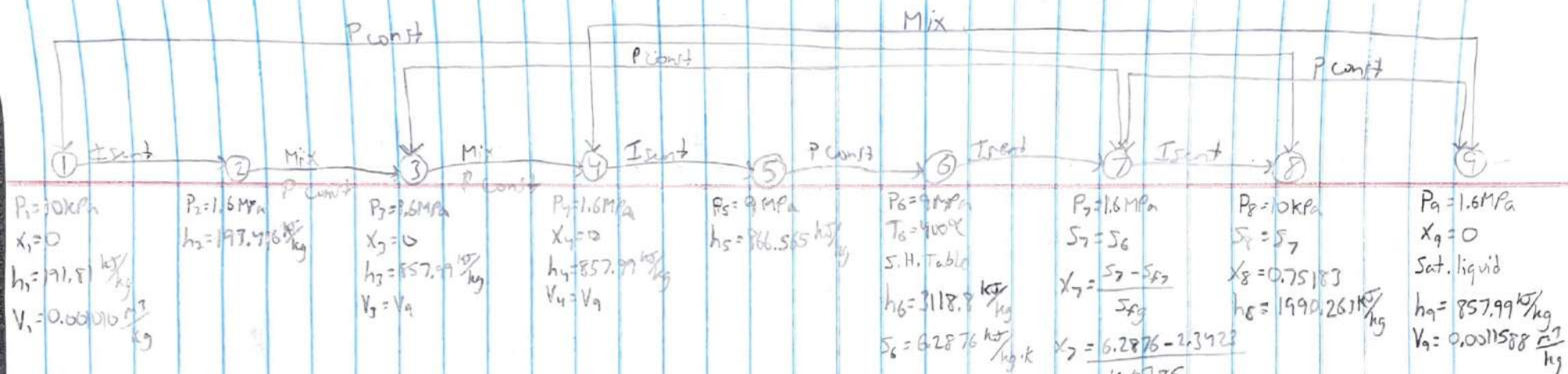
$$\begin{aligned}
 E &= \frac{W_{\text{net}} + Q_{\text{power}}}{Q_{\text{in}}} \\
 &= \frac{58512.28 + 29173.513}{27027.8} \\
 &= 3.244 = 324\% \quad \leftarrow \text{Math error?}
 \end{aligned}$$

10-72)



Given: $\gamma = 35\% = 0.35$
 $W_{net} = 25 \text{ MW}$

See next page for states.



find h_2 and h_5

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

$$h_5 = V_4(P_5 - P_4) + h_4$$

$$W_{T_{out}} = (h_5 - h_7) + (1 - y)(h_7 - h_8)$$

$$= (3118.8 - 2729.406) + (1 - 0.75)(2729.406 - 1990.263)$$

$$W_{T_{out}} = 869.8367 \text{ kJ/kg}$$

$$W_{P_{in}} = (1 - y)W_{P1} + W_{P2}$$

$$= (0.75)(h_2 - h_1) + (h_5 - h_4)$$

$$= (0.75)(193.416 - 191.81) + (866.565 - 857.99)$$

$$= 9.1371 \text{ kJ/kg}$$

$$W_{net} = W_T - W_{P_{in}}$$

$$= 869.8367 - 9.1371$$

$$W_{net} = 860.69 \text{ kW}$$

a) $\dot{W}_{net} = \dot{m}(\dot{W}_{out})$

$$25 \times 10^3 = \dot{m}(860.69)$$

$$\dot{m} = 29.046 \text{ kg/s}$$

Bonus question on next page →

Bonus: find $\dot{m}$ at each state

① $\dot{m}_1 = \dot{m}_T = 29.046 \text{ kg/s}$

② $\dot{m}_2 = \dot{m}_T = 29.046 \text{ kg/s}$

③ $\dot{m}_2 = \dot{m}_9 = 5.085 \text{ kg/s}$

④ $\dot{m}_4 = \dot{m}_2 + \dot{m}_9 = 10.17 \text{ kg/s}$

⑤ $\dot{m}_5 = \dot{m}_T = 29.046 \text{ kg/s}$

⑥ $\dot{m}_6 = \dot{m}_T = 29.046 \text{ kg/s}$

⑦ $\dot{m}_7 = y \dot{m}_T = (0.35)(29.046) = 10.17 \text{ kg/s}$

⑧ $\dot{m}_8 = (1-y) \dot{m}_T = (0.65)(29.046) = 18.88 \text{ kg/s}$

⑨ $\dot{m}_9 = \frac{\dot{m}_7}{2} = \frac{10.17}{2} = 5.085 \text{ kg/s}$