

ME 200 Homework 8

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1. a)

$$s_1 = 8.2570$$

$$u_1 = 2430.1$$

$$\begin{aligned} T_2 &= \frac{500 - 440}{8.3251 - 8.1538} \times (8.2570 - 8.1538) + 440 \\ &= 476.147 \text{ } ^\circ C \end{aligned}$$

$$\begin{aligned} u_2 &= \frac{3130 - 3030.6}{8.3251 - 8.1538} \times (8.2570 - 8.1538) + 3030.6 \\ &= 3090.48 \end{aligned}$$

$$\begin{aligned} \Delta u &= u_2 - u_1 \\ &= 660.384 \text{ kJ/kg} \end{aligned}$$

b)

$$s_1 = 0.8 \times 8.9501 + 0.2 \times 0.1212 = 7.18432$$

$$h_1 = 0.8 \times 2574.3 + 0.2 \times 167.57 = 2092.95$$

$$\begin{aligned} T_2 &= \frac{320 - 280}{7.1962 - 7.0465} \times (7.18432 - 7.0465) + 280 \\ &= 316.826 \text{ } ^\circ C \end{aligned}$$

$$\begin{aligned} h_2 &= \frac{3093.9 - 3008.2}{7.1962 - 7.0465} \times (7.18432 - 7.0465) + 3008.2 \\ &= 3087.1 \end{aligned}$$

$$\begin{aligned} \Delta h &= u_2 - u_1 \\ &= 3087.1 - 2092.95 \\ &= 994.149 \text{ kJ/kg} \end{aligned}$$

2.

$$u_1 = 6229$$

$$s_1^\circ = 197.732$$

$$u_2 = 7689$$

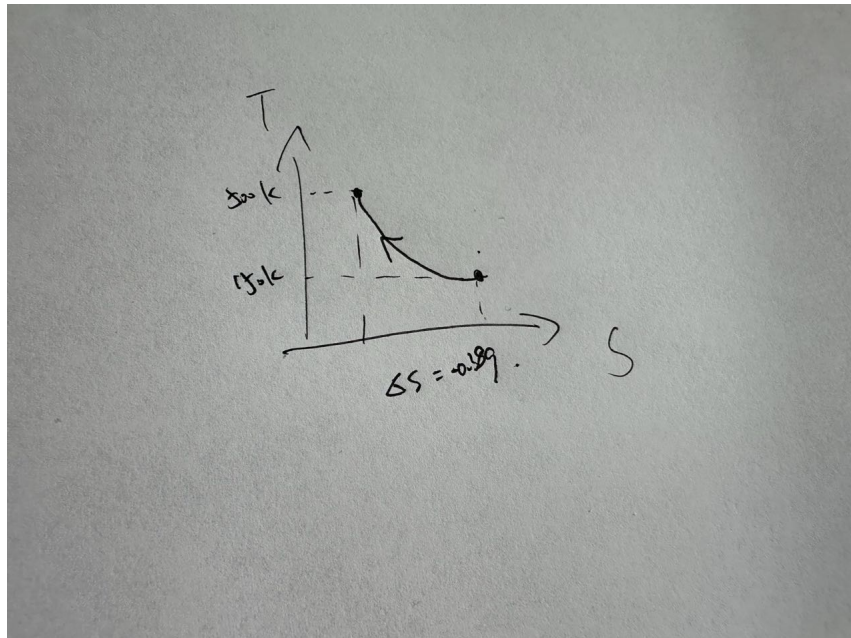
$$s_2^\circ = 203.842$$

a)

$$\begin{aligned} Q &= W - n(u_2 - u_1) \\ &= -300 + 0.1(7689 - 6229) \\ &= -154 \text{ kJ} \end{aligned}$$

b)

$$\begin{aligned} \Delta s &= n \left((s_2^\circ - s_1^\circ) - R \ln \left(\frac{P_2}{P_1} \right) \right) \\ &= 0.1 \left((203.842 - 197.723) - 8.314 \ln \left(\frac{500}{150} \right) \right) \\ &= -0.389 \text{ kJ/K} \end{aligned}$$



3.

$$s_1 = s_f = 1.9426$$

$$u_1 = u_f = 674.79$$

$$Q = mT(s_2 - s_1)$$

$$2700 = 2 \times (160 + 273)(s_2 - 1.9426)$$

$$s_2 = 5.0604$$

for $T_2 = 160$:

$$P_2 = \boxed{6.1823 \text{ bar}}$$

$$5.0604 = 1.9426 + x(4.8066)$$

$$x = 0.649$$

$$u_2 = u_f + xu_{fg}$$

$$= 674.79 + 0.649 \times 1893.0$$

$$= 1903.347 \Delta U = m(u_2 - u_1)$$

$$= 2(1903.347 - 674.79)$$

$$= 2457.114$$

$$W = Q - \Delta U$$

$$= 2700 - 2457.114$$

$$= \boxed{242.886 \text{ kJ}}$$

4.

$$\begin{aligned}
h_3 &= h_f + x_3(h_g - h_f) \\
&= 583.77 + 0.9 \times (1634.23 - 583.77) \\
&= 1529.18 \\
s_3 &= 2.2706 + 0.9(5.5213 - 2.2706) \\
&= 5.196 = s_2 \\
h_2 &= 1244 \\
h_4 &= h_f = 583.77 \\
s_4 &= s_f = 2.2706 \\
s_1 &= s_4 = 2.2706 \\
s_1 &= s_f + x_1(s_g - s_f) \\
x_1 &= 0.237 \\
h_1 &= h_f + x_1(h_g - h_f) \\
&= 206.76 + 0.237(1566.47 - 206.76) \\
&= 529.17 \\
W_n &= nm((h_3 - h_2) - (h_4 - h_1)) \\
&= 50 \times 0.1 \times ((1529.18 - 1244) - (583.77 - 529.17)) \\
&= 1152.9 \text{ kJ}
\end{aligned}$$

5.

$$\begin{aligned}
p_1 &= 1\text{bar} \\
u_1 &= 2537.3 \\
s_1 &= 7.4668 \\
p_2 &= 100\text{bar} \\
s_2 &= s_1 = 7.4668 \\
u_2 &= (7.4668 - 7.2670) \frac{3515.1 - 3434.7}{7.2670 - 7.1687} + 3512.1 \\
&= 3675.52 \\
T_2 &= (7.4668 - 7.2670) \frac{740 - 700}{7.2670 - 7.1687} + 740 \\
&= 821.302 \text{ } ^\circ C \\
W/m &= (u_1 - u_2) \\
&= -1142.7\text{kJ/kg}
\end{aligned}$$