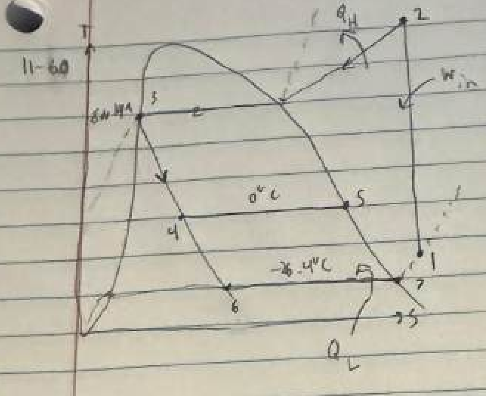
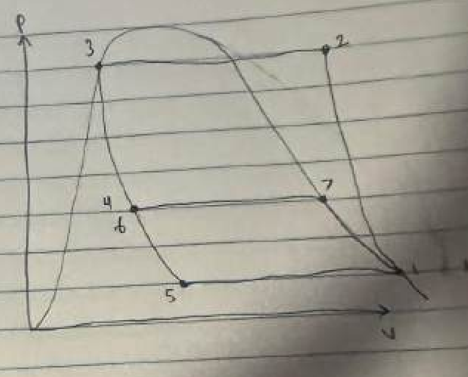
11-60





1 → 2 → 3 → 4 →

1	2	3	4
$P_1 = 800$ kpa	$S_2 = S_1$	$h_3 = h_4$	$T_4 = 0$
$h_1 = 1025.2$	$P_2 = 800$ kpa	$P_3 = 180$ psia	
$S_1 = 0.2382$	$h_2 = 286.35$	$h_3 = 51.51$ Btu/lbm $= h_4$	

→ 5 → 6 → 7 → 1

5	6	7
$T_5 = 0$	$T_6 = -26.4°C$	$P_7 = 10$ psia
$P_5 = 60$ psia	$h_6 = 81.5$ Btu/lbm	$h_7 = 98.69$ Btu/lbm
sat table		[illegible]
$h_5 = 110.13$ Btu/lbm		

$Q_1 = m_1(h_5 - h_4)$

$m_1 = \frac{15{,}000 \text{ Btu/h}}{110.13 - 51.51}$

$m_1 = 255.9$ lbm/h

$Q_{L,2} = m_2(h_7 - h_6)$

$Q_{L,2} = 583.7$ lbm/h

$m_1 h_5 + m_2 h_7 = (m_1 + m_2) h_1$

$h_1 = \frac{m_1 h_5 + m_2 h_7}{m_1 + m_2}$

$h_1 = 102.52$ Btu/lbm

$W_{in} = (m_1 + m_2)(h_2 - h_1)$

$W_{in} = 6.180$ kW

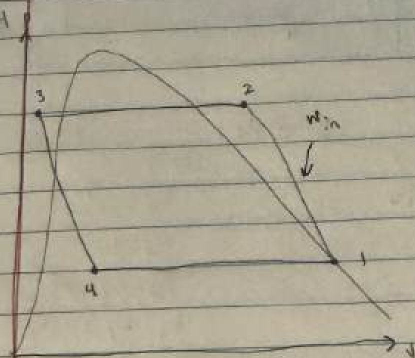
$COP_R = \frac{Q_L}{W_{in}} = \frac{2400 + 1500}{6.180}$

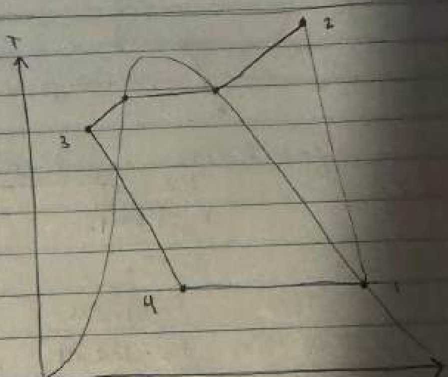
$COP = 1.85$

11-38 The temperatures should be 20° C and 35° C. A 10° C temperature difference is effective for heat transfer

The saturations pressures for the temperatures is 0.133 Mpa and 0.888 Mpa. The recommended pressures are 0.133 Mpa and 0.889 Mpa.

11-44





Isenthalpic

1 → 2 → 3 → 4

1	2	3	4
200 kPa	800 kPa	750 kPa	200 kPa
54°C	50°C	47°C	$h_4 = 89.265$
$h_1 = 247.87$	$h_2 = 2086.71$	$h_3 = 89.265$	

for d. $h_1 = 244.5$ $h_2 = 267.34$ $h_3 = h_4 = 94.22$

$Q_{in} = \dot{m}(h_2 - h_3)$ $W_{comp} = \dot{m}(h_2 - h_1)$

$COP = \frac{Q_{in}}{W_{comp}} \rightarrow \frac{h_2 - h_3}{h_2 - h_1} = \frac{267.34 - 94.22}{267.34 - 244.5}$

$COP_{HP} = 7.5788$

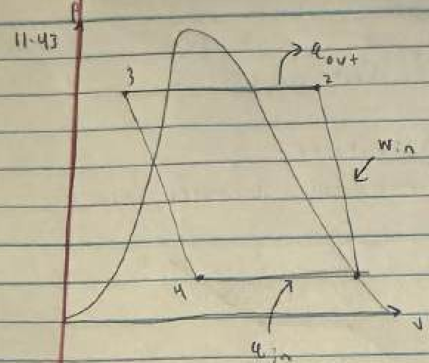
$\eta_c = \frac{h_{2s} - h_1}{h_2 - h_1} = \frac{277.23 - 247.87}{2086.71 - 247.87} = 0.75539$ → 75.53%

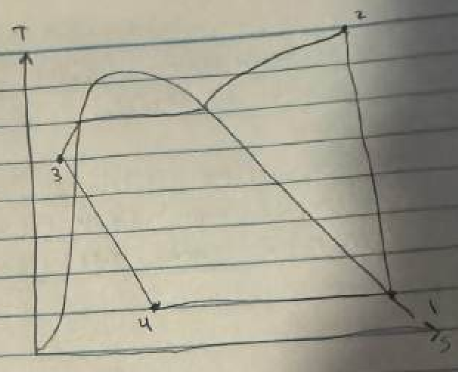
$Q_H = 0.022 \text{ kg/s} (286.67 - 94.22) = 4.2339 \text{ kW}$

$W_{in} = 0.022 \text{ kg/s} (286.71 - 247.87) = 0.8536 \text{ kW}$

$COP = \frac{4.2339}{0.8536} = 4.96$

11-43





1 $\xrightarrow{\text{const Entropy}}$ 2 $\xrightarrow{P = \text{const}}$ 3 $\xrightarrow{\text{Isenthalpic}}$ 4 $\xrightarrow{P = \text{const}}$

1	2	3	4
$x_1 = 1$	$P_2 = 1.4\ MPa$	$P_3 = P_2$	$T_4 = 20°C$
$P_1 = P_4$	$S_2 = S_1$		$x_4 = 0.23$
$P_1 = 572.05\ kPa$	Superheated		$P_4 = 572.05$
$h_1 = 261.59\ kJ/kg$	$h_2 = 280.018$		$h_4 = h_f + x_4 h_{fg}$
$s_1 = 0.92234$	$T_2 = 55.57°C$		$h_4 = 121.24\ kJ/kg$

$Q_{in} = \dot{m}\, c_{pw}(T_{in} - T_{out})$ $c_{pw} = 4.18$

$Q_{in} = 2.717\ kW$

$W_{in} = W_{in\,re} + Q_{lost}$ $W_{in} = \dot{m}(h_2 - h_1)$

$\dot{m} = \frac{Q_{in}}{(h_1 - h_4)} = 0.01936$

$W_{in\,re} = 0.3567\ kW$ $W_{in} = 0.6567\ kW$ $Q_{out} = 3.3737\ kW$

$Q_{out} = \dot{m}(h_2 - h_3)$

$h_3 = 105.754\ kJ/kg$

Using sat table: $T_3 = 38°C$

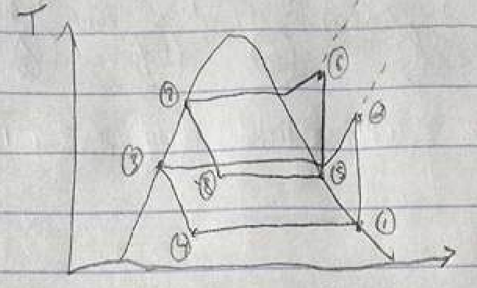
$\Delta T_{sub} = T_{sat@1.4} - T_3 = 14.386°C$ $\dot{m} = 0.01936\ kg/s$

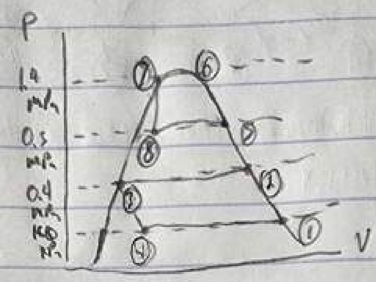
$Q_{out} = 3.3737\ kW$ $COP = \frac{Q_{out}}{W_{in}} = 5.1374$

$W_{in} = 0.3767\ kW$

$COP_{Carnot} = \frac{1}{1 - \frac{T_L}{T_H}} = \frac{1}{1 - \frac{(25 + 273.15)}{(50 + 273.15)}} = 12.93$ $W_{in} = 0.261\ kW$

11-58





(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$P_1 = 100\text{ kPa}$	$P_2 = 0.5\text{ MPa}$	$P_3 = 0.5\text{ MPa}$	$P_4 = 160\text{ kPa}$	$P_5 = 0.4\text{ MPa}$	$P_6 = 1.4\text{ MPa}$	$P_7 = 1.4\text{ MPa}$	$P_8 = 0.4\text{ MPa}$
$h_1 = 241\text{ kJ/kg}$	$h_2 = 265\text{ kJ/kg}$	$h_3 = 73.4\text{ kJ/kg}$	$h_4 = 73.4$	$h_5 = 256\text{ kJ/kg}$	$h_6 = 282\text{ kJ/kg}$	$h_7 = 127\text{ kJ/kg}$	$h_8 = 127\text{ kJ/kg}$
$s_1 = 942\text{ J/kg·K}$				$s_5 = 927\text{ J/kg·K}$	$s_5 = s_6$		

$s_2 = s_1$

$$\eta_{c_1} = \eta_{c_2} = 0.8 = \frac{h_2 - h_1}{h_{2_1} - h_1} = \frac{h_6 - h_5}{h_{6_1} - h_5}$$

$$\eta_{c_1} = 0.8 = \frac{265 - 241}{h_2' - 241} = 271\text{ kJ/kg}$$

$$\eta_{c_2} = 0.8 = \frac{282 - 256}{h_{6_1} - 256} = 288.5\text{ kJ/kg}$$

a) $\dot{m}_L (h_{2_1} - h_3) = \dot{m}_H (h_5 - h_8)$

$0.11(271 - 73.4) = \dot{m}_H (256 - 127) \quad \dot{m}_H = 0.169\text{ kg/sec}$

b) $\dot{Q}_L = \dot{m}_L (h_1 - h_4) = 0.11(241 - 73.4) = 18.44\text{ kW}$

c) $COP = \frac{\dot{Q}_L}{W_{in}} \quad W_{in} = \dot{m}_L (h_{2_1} - h_1) + \dot{m}_H (h_{6_1} - h_5)$

$= 0.11(271 - 241) + 0.169(288.5 - 256)$

$W_{in} = 8.79\text{ kW}$

$$COP = \frac{18.44}{8.79} = 2.12$$