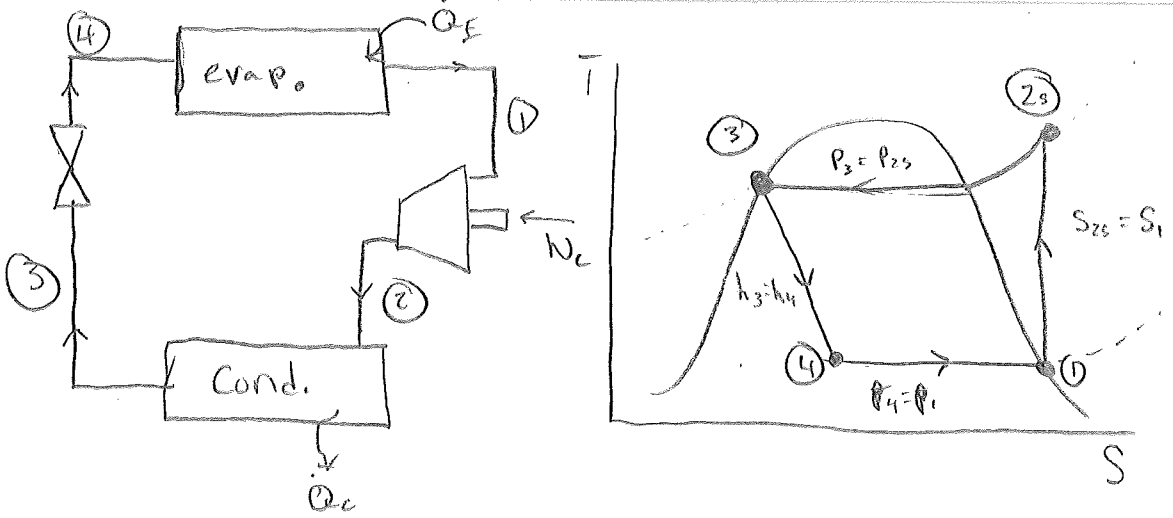
1



State	T	P	V	h	S	X
1	-15.62°C	160 kPa*	0.1229	237.97	0.9295	Saturated vapor
2s		900 kPa*		273.73	0.9295	Superheat
3	35.53	900 kPa		99.56	0.3656	Saturated liquit
4	-15.62°C	160 kPa*		99.56		

$\dot{Q}_{in} = \dot{Q}_E = 300 kJ/min$
$= 5 kJ/s$

$$Y = Y_1 + \frac{X - X_1}{X_2 - X_1}(Y_2 - Y_1)$$

Y	X
271.25	0.9217
Y	0.9295
282.34	0.9566

$$Y = 271.25 + \frac{0.9295 - 0.9217}{0.9566 - 0.9217}(282.34 - 271.25)$$

$Y = 273.73 \ kJ/kg = h_{2s}$

$\dot{Q}_{in} = \dot{m}(h_1 - h_4)$

$\dot{m} = \frac{5 kJ/s}{(237.97 - 99.56)} = 0.036 kg/s$ ✓

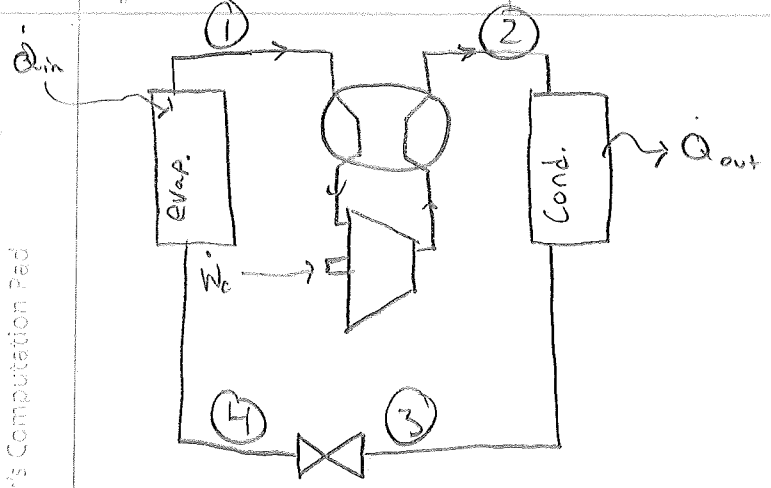
$\dot{W}_c = (h_2 - h_1)\dot{m}$ ✓ $= 0.036(273.73 - 237.97)$

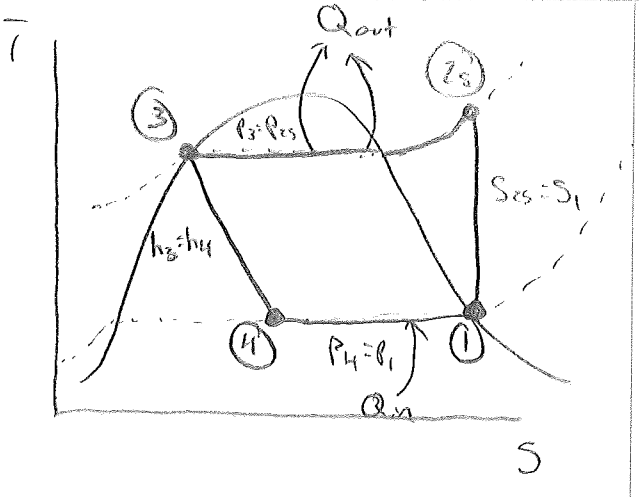
$\dot{W}_c = 1.29 kW$ ✓

$$COP = \frac{\dot{Q}_E}{\dot{W}_c} = \frac{(237.97 - 99.56)0.036}{1.29} = 3.88$$ ✓

$$X_4 = \frac{h_4 - h_f}{h_g - h_f} = \frac{99.56 - 29.78}{237.97 - 29.78} = 0.34$$ ✓

5/5





State	T	P	V	h	S	X
1	2.48	320 kPa		248.66	0.9177	Sat. Vap
2		800 kPa		267.58	0.9178	Superheat
3		800 kPa		93.42		Sat. Liq.
4	2.48	320 kPa		93.42	0.2089	

$\dot{Q}_{out} = 75000 \text{ kJ/hr}$
$= 20.83 \text{ kJ/s}$

$$Y = Y_1 + \left(\frac{X - X_1}{X_2 - X_1}\right)(Y_2 - Y_1)$$

Y	X
264.15	0.9066
Y	0.9177
273.66	0.9374

$$h_{2s} = Y = 264.15 + \frac{0.9177 - 0.9066}{0.9374 - 0.9066}(273.66 - 264.15)$$

$h_{2s} = 267.58$

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

$\dot{m} = \frac{20.83}{(267.58 - 93.42)} = 0.12 \text{ kg/s}$ ✓

$\dot{W}_c = \dot{m}(h_2 - h_1) = 0.12(267.58 - 248.66) = 2.27 \text{ kW}$ ✓

$COP_{hp} = \frac{\dot{Q}_{out}}{\dot{W}_c} = \frac{20.83}{2.27} = 9.18$ ✓

electric requires → 75,000 kJ/h

heat pump requires → 8173.44 kJ/h

$$\dot{Q}_e = (h_1 - h_4)\,\dot{m} = (248.66 - 93.42)\,0.12 = 18.63\ kW$$

$$\dot{m}_w = \frac{\dot{Q}_{evap}}{C_p \Delta T} = \frac{18.63}{4.2\ kJ/kg\cdot{}^\circ C\,(8^\circ C)} = 0.55\ kg/s$$

5/5