



a)  $W_c = h_2 - h_1$

$$h_1 = h_g @ -5^\circ = 403.19 \text{ kJ/kg}$$

$$h_2 = h_{2'} + C_p(T_2 - T_{2'})$$

$$h_{2'} = 413.93 \text{ kJ/kg}$$

$$s_1 = s_2 = s_{2'} + C_p \ln\left(\frac{T_2}{T_{2'}}\right)$$

$$s_1 = 1.7575 \text{ kJ/kg K}$$

$$s_{2'} = 1.7101 \text{ kJ/kg K}$$

$$T_2 = T_{2'} e^{\left(\frac{s_1 - s_{2'}}{C_p}\right)}$$

$$C_p = 0.919 \text{ kJ/kg K}$$

$$T_2 = (273 + 30) e^{\left(\frac{1.7575 - 1.7101}{0.919}\right)} - 273$$

$$= 46.03 \text{ K}$$

$$h_2 = 413.93 + 0.919(46.03 - 30)$$

$$= 428.66 \text{ kJ/kg}$$

$$W_c = h_2 - h_1 = 428.66 - 403.19$$

$$= 25.47 \text{ kJ/kg}$$

6)  $RE = h_1 - h_4 = h_1 - h_3$

$$h_3 = 236.69 \text{ kJ/kg}$$

$$RE = 403.19 - 236.69 \text{ kJ/kg}$$

$$= 166.5 \text{ kJ/kg}$$

c)  $HE = RE + W_c = 166.5 + 25.47$

$$= 191.97 \text{ kJ/kg}$$

$$COP = \frac{RE}{W_c} = \frac{166.5}{25.47}$$

$$= 6.53$$