Homework #9:

5-10:

a): $Q_{in} = \Delta U + W_{out}$

$$= \int p\,dv$$

$$= \int p\,d\left(\frac{nRT}{p}\right)$$

$$= nRT \cdot (-1) \int_{p_1}^{p_2} \frac{1}{p}\,dp$$

$$= nRT(-1) \cdot \ln\frac{p_2}{p_1}$$

$$= \frac{3}{32} \cdot 8.314 \cdot (273.15 + 80) \cdot \ln\frac{250}{110}$$

$$= 225.98\ KJ$$

b): $Q_{in} = 225.98 * 0.85 = 192.08\ KJ$

5-17:

a): $Q_{add} = W_{out}$

$$= \int_{V_1}^{V_2} p\,dV = \int_{V_1}^{V_2} \frac{nRT}{V}\,dV = nRT \ln\frac{V_2}{V_1}$$

$$= \frac{P_1 V_1}{\cancel{R}T} \cdot \cancel{R}T \ln\frac{V_2}{V_1}$$

$$= 500 \cdot 0.05 \ln\frac{0.1}{0.05} = 17.33\ KJ$$

b): $\frac{Q_H}{T_H} + \frac{Q_L}{T_L} = 0 \Rightarrow Q_L = -\frac{Q_H}{T_H} \cdot T_L = -17.33 \cdot \frac{273.15}{273.15+90}$

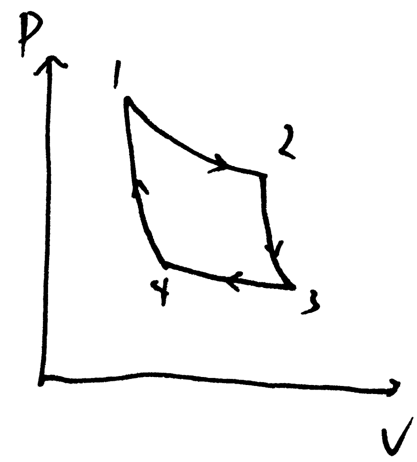
$$= -13.03\ kJ$$

5-58):

$300F = 148.89°C.$

$100F = 82.2°C$

$100B = 105.5KJ$



$$\frac{W_{out}}{Q_H} = \frac{T_H - T_L}{T_H}$$

$$Q_H = W_{out} \cdot \frac{T_H}{T_H - T_L} = Q_L \cdot \frac{T_H}{T_L}.$$

$$\Rightarrow Q_L = \frac{W_{out} \cdot T_H}{T_H - T_L} \cdot \frac{T_L}{T_H}$$

$$= \frac{105.5 \cdot 148.89}{148.89 - 82.2} \cdot \frac{82.2}{148.89}$$

$$= 130.03 \text{ KJ}$$

5-66):

$$\beta_{HP} = \frac{|Q_H|}{W_{in}} = \frac{|Q_H|}{|Q_H| - |Q_L|} = \frac{T_H}{T_H - T_L}$$

T_L °C	T_H °C	β_{HP}
-5	30	8.66
-5	20	11.7
-5	10	18.9
-50	20	4.2
-150	20	1.7.
-250	20	1.1

Ex:

$$\beta_{HP1} = \frac{273.15+30}{35} = 8.66.$$

5-69):

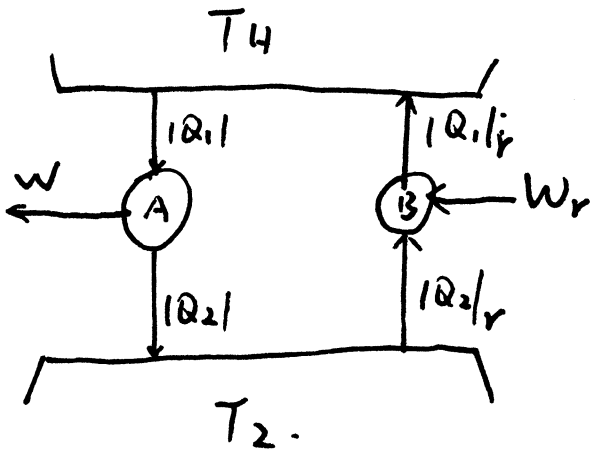
300psia = 2068.2 KPa.

1100F = 593.3°C

$T_H = 3 \cdot T_L \Rightarrow |Q_H| = 3 \cdot |Q_L|$

$W = Q_H - Q_L = \frac{2}{3} \cdot 55{,}000 = 36{,}666.67$ B/h.

5-73):

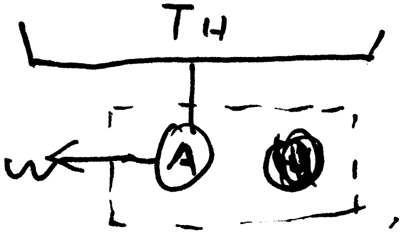


A: Normal

B: Reversible.

Prove: Assume that $\eta_A > \eta_B$, $|Q_2| = |Q_2|_r$.

From above, we can get



this result disobey Kelvin statement.