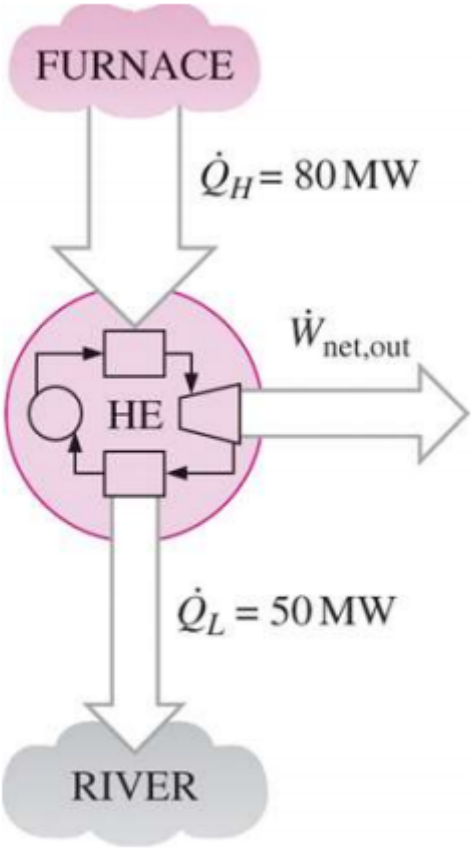
EX_6

EX 6.1

Heat is transferred to a heat engine from a furnace at a rate of $80\ MW$. If the rate of waste heat rejection to a nearby river is $50\ MW$, determine the net power output and the thermal efficiency for this heat engine.

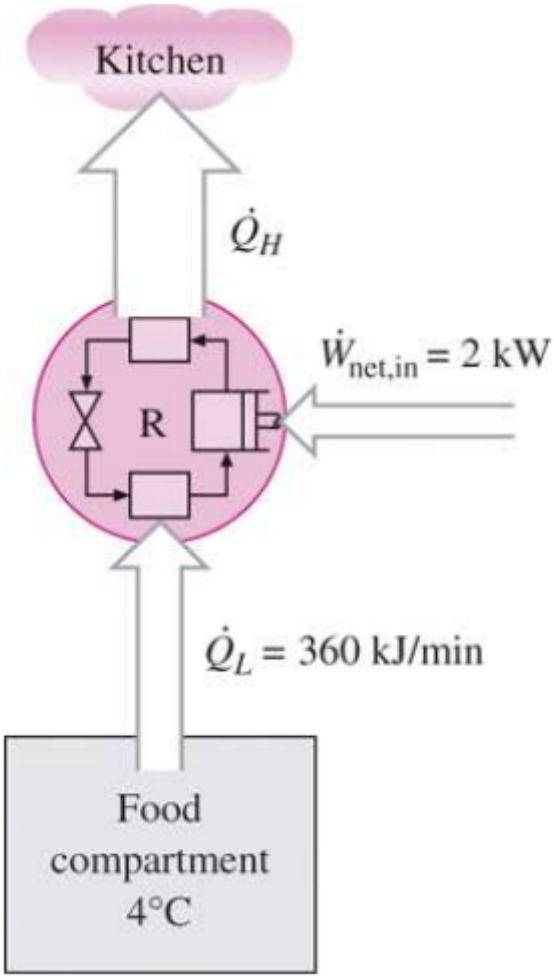


$$\dot{W}_{out} = \dot{Q}_H - \dot{Q}_L = 30MW$$

$$\eta_{th} = \frac{\dot{W}_{out}}{\dot{Q}_H} = 0.375$$

EX 6.2

The food compartment of a refrigerator is maintained at $4^\circ C$ by removing heat from it at a rate of $360\ kJ/min$. If the required power input to the refrigerator is $2\ kW$, determine (a) the coefficient of performance of the refrigerator and (b) the rate of heat rejection to the room that houses the refrigerator



(a)

$$COP_R = \frac{\dot{Q}_L}{\dot{W}_{in}} = \frac{6kW}{2kW} = 3$$

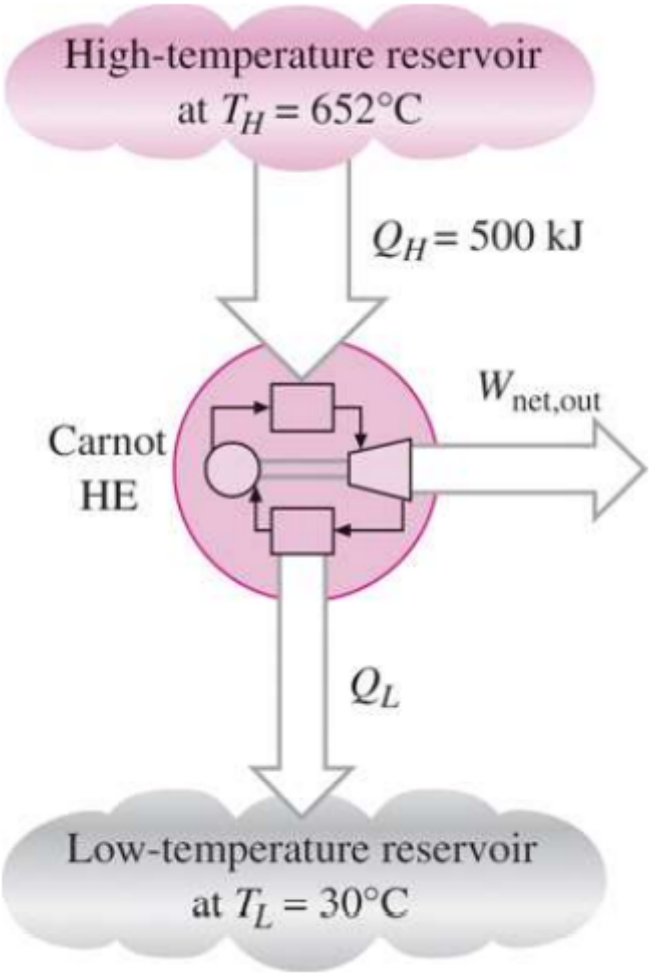
(b)

$$\dot{Q}_H = \dot{W}_{in} + \dot{Q}_L = 8kW$$

EX 6.3

A Carnot heat engine, shown in the following figure, receives $500\ kJ$ of heat per cycle from a high temperature source at $652^\circ C$ and rejects heat to a low-temperature sink at $30^\circ C$.

Determine (a) the thermal efficiency of this Carnot engine and (b) the amount of heat rejected to the sink per cycle.



(a)

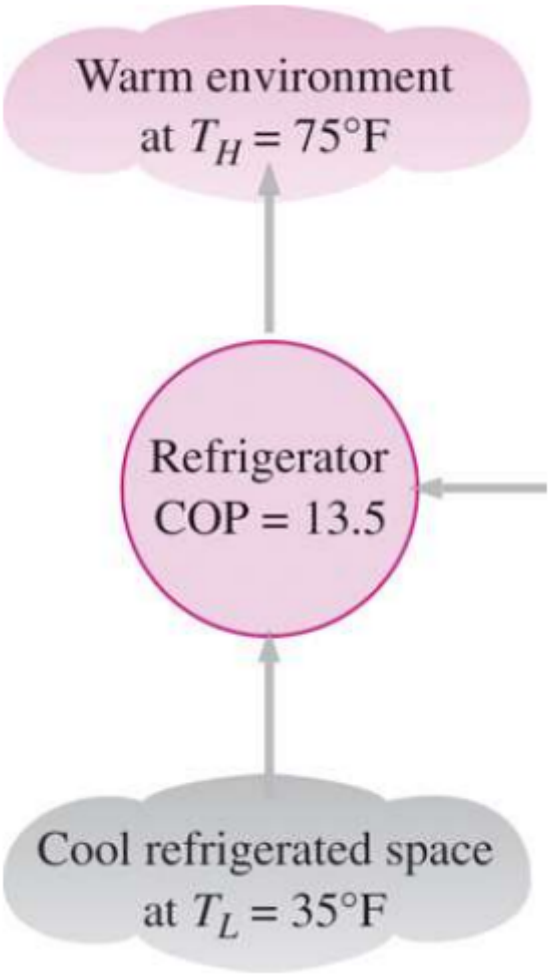
$$\eta_{th} = 1 - \frac{T_L}{T_H} = 1 - \frac{30 + 273.15}{652 + 273.15} = 67.23\%$$

(b)

$$Q_L = \frac{T_L}{T_H} Q_H = \frac{30 + 273.15}{652 + 273.15} \times 500 = 163.84kJ$$

EX 6.4

An inventor claims to have developed a refrigerator that maintains the refrigerated space at $35^\circ F$ while operating in a room where the temperature is $75^\circ F$ and that has a COP of 13.5. Is this claim reasonable?



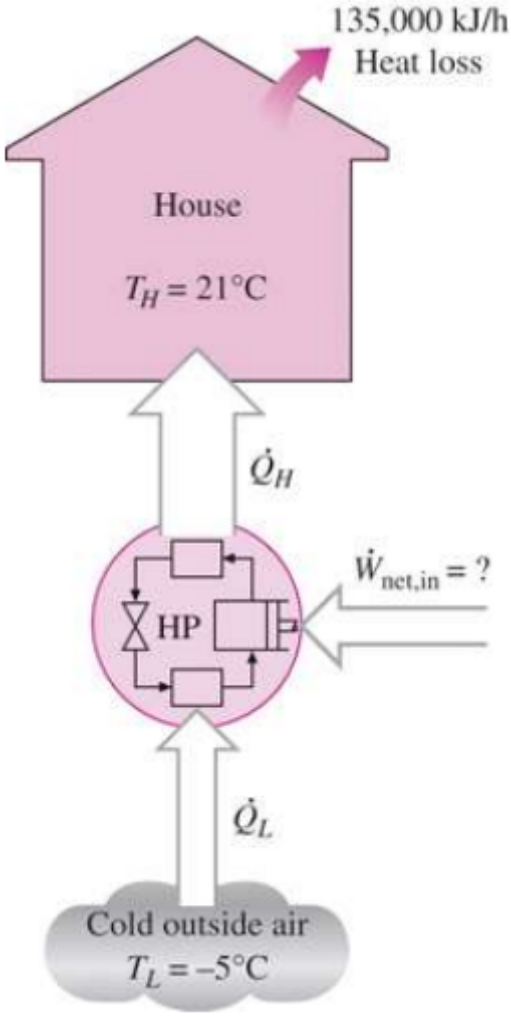
$$COP_R = \frac{Q_L}{Q_H - Q_L} = \frac{1}{\frac{Q_H}{Q_L} - 1} = \frac{1}{\frac{T_H}{T_L} - 1} = \frac{1}{\frac{75+460}{35+460} - 1} = 12.375 < 13.5$$

which is impossible

EX 6.5

A heat pump is to be used to heat a house during the winter, as shown in the following figure. The house is to be maintained at $21^\circ C$ at all times. The house is estimated to be losing heat at a rate of $135000\ kJ/h$ when the outside temperature drops to $-5^\circ C$.

Determine the minimum power required to drive this heat pump.



$$COP_{HP} = \frac{\dot{Q}_H}{\dot{Q}_H - \dot{Q}_L}$$

$$= \frac{1}{1 - \frac{\dot{Q}_L}{\dot{Q}_H}} = \frac{1}{1 - \frac{T_L}{T_H}}$$

$$= \frac{1}{1 - \frac{-5+273.15}{21+273.15}} = 11.31$$

$$\dot{W}_{in} = \frac{\dot{Q}_H}{11.31} = 3.32kW$$