Given: $kJ := 1000 J$

A heat pump is to be used to heat a house during winter. The house is to be maintained at 21°C. The house is estimated to lose heat at a rate of 135,000 kJ/hr when the outside temperature drops to -5°C.

Required:

Determine the minimum power required to drive this heat pump.

Solution:

The cycles high and low temperatures are defined as

$$T_H := 21\,°C = 294.15\,K \qquad\qquad T_L := (-5)\,°C = 268.15\,K$$

The heat accepted by the cycle is defined as

$$Q'_H := 135000\,\frac{kJ}{hr} = 37.5 \cdot kW$$

The Carnot COP of the cycle may be found by

$$COP_{HP,rev} := \frac{1}{1 - \dfrac{T_L}{T_H}} = 11.313$$

The minimum power required to power the cycle is the Carnot work which is found by

$$\boxed{W'_{net,in} := \frac{Q'_H}{COP_{HP,rev}} = 3.315 \cdot kW}$$