

**Given:**

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

$$T_H := 21 \text{ }^{\circ}\text{C} = 294.15 \text{ K} \quad T_L := (-5) \text{ }^{\circ}\text{C} = 268.15 \text{ K}$$

The heat accepted by the cycle is defined as

$$\dot{Q}'_H := 135000 \frac{\text{kJ}}{\text{hr}} = 37.50 \text{ kW}$$

The Carnot COP of the cycle may be found by

$$COP_{HP,rev} := \frac{1}{1 - \frac{T_L}{T_H}} = 11.31$$

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

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