

Given: $\text{kJ} := 1000\text{J}$

During an experiment conducted in a room at 25°C , a lab assistant measures that a refrigerator that draws 2 kW of power has removed 30,000 kJ of heat over at 20 minute period from a refrigerated space maintained at -30°C .

Required:

Determine the COP of the refrigerator and whether it is possible.

Solution:

The high and low temperatures of the cycle are defined as

$$T_H := 25^\circ\text{C} = 298.15\text{ K} \quad T_L := (-30)^\circ\text{C} = 243.15\text{ K}$$

The rate of net work input to the cycle is defined as

$$\dot{W}_{\text{net,in}} := 2\text{ kW}$$

The heat accepted by the cycle is defined as

$$Q_L := 30000\text{ kJ}$$

The period of time is defined as

$$\Delta t := 20\text{ min}$$

The net work input of the cycle is found by

$$W_{\text{net,in}} := \dot{W}_{\text{net,in}} \cdot \Delta t = 2400 \cdot \text{kJ}$$

The COP of the cycle is found by

$$\text{COP}_R := \frac{Q_L}{W_{\text{net,in}}} = 12.5$$

The Carnot COP of the cycle is found by

$$\text{COP}_{R,\text{rev}} := \frac{1}{\frac{T_H}{T_L} - 1} = 4.421$$

Since $\text{COP}_{R,\text{rev}} < \text{COP}_R$, the cycle is impossible.