251.

Problem 26.15 (RHK)

An air conditioner takes air from a room at $70^0\,\mathrm{F}$ *and transfers to the outdoors, which is at* $95^0\,\mathrm{F}$. *We have to find out the amount in joules of heat transferred from the room for each of electrical energy required to run the refrigerator.*

Solution:

From the data of the problem we note that

$$T_L = 70.0^0\,\mathrm{F} = (70-32)\times\frac{5}{9}{}^0\mathrm{C} = 21.1^0\mathrm{C} = 294.1\ \mathrm{K}.$$

$$T_H = 95.0^0\,\mathrm{F} = (95-32)\times\frac{5}{9}{}^0\mathrm{C} = 35^0\mathrm{C} = 308\ \mathrm{K}.$$

We assume that the air conditioner is operating with maximum efficiency, which is the efficiency of a Carnot engine. For a Carnot refrigerator the work W done on the engine in each cycle and the heat absorbed at the lower temperature Q_L are related to the low and high temperatures as

$$\frac{W}{Q_L} = \frac{T_H - T_L}{T_L}.$$

Therefore,

$$Q_L = \frac{W \times T_L}{T_H - T_L}.$$

We want find the heat absorbed from the room for each joule of electrical energy used by the refrigerator. We should calculate Q_L for $W = 1.0$ J. We find

$$Q_L = \frac{1.0 \times 294.1}{308.0 - 294.1} \text{ J} = 21.15 \text{ J}.$$