

Given:

A Carnot heat engine receives 500 kJ of heat per cycle from a high temperature source at 652°C and rejects heat to a low temperature sink at 30°C.

Required:

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

Solution:

The heat accepted by the heat engine is defined as

$$Q_{H,rev} := 500 \text{ kJ}$$

The temperatures of the high and low temperature reservoirs are defined as

$$T_H := 652 \text{ }^{\circ}\text{C} = 925.15 \text{ K} \quad T_L := 30 \text{ }^{\circ}\text{C} = 303.15 \text{ K}$$

The thermal efficiency of the Carnot engine is then found by

$$\eta_{th,rev} := 1 - \frac{T_L}{T_H} = 67.23 \%$$

Using the definition of thermal efficiency, the heat rejected by the cycle may be found by

$$\eta_{th} = 1 - \frac{Q_L}{Q_H} \quad \text{or} \quad Q_{L,rev} := Q_{H,rev} \cdot (1 - \eta_{th,rev}) = 163.8 \text{ kJ}$$