19.40. **Model:** The ideal gas in the Carnot engine follows a closed cycle in four steps. During the isothermal expansion at temperature T_H, heat Q_H is transferred from the hot reservoir into the gas. During the isothermal compression at T_C, heat Q_C is removed from the gas. No heat is transferred during the remaining two adiabatic steps.
Solve: The thermal efficiency of the Carnot engine is

$$\eta_{\text{Carnot}} = 1 - \frac{T_C}{T_H} = \frac{W_{\text{out}}}{Q_H} \Rightarrow 1 - \frac{323\text{ K}}{573\text{ K}} = \frac{W_{\text{out}}}{1000\text{ J}} \Rightarrow W_{\text{out}} = 436\text{ J}$$

Using $Q_H = Q_C + W_{\text{out}}$, we obtain

$$Q_{\text{isothermal}} = Q_C = Q_H - W_{\text{out}} = 1000\text{ J} - 436\text{ J} = 564\text{ J}$$