19.24. Solve: **(a)** The efficiency of the Carnot engine is

$$\eta_{\text{Carnot}} = 1 - \frac{T_{\text{C}}}{T_{\text{H}}} = 1 - \frac{300\ \text{K}}{500\ \text{K}} = 0.40 = 40\%$$

(b) An engine with power output of 1000 W does $W_{\text{out}} = 1000$ J of work during each $\Delta t = 1$ s. A Carnot engine has a heat input that is

$$Q_{\text{in}} = \frac{W_{\text{out}}}{\eta_{\text{Carnot}}} = \frac{1000\ \text{J}}{0.40} = 2500\ \text{J}$$

during each $\Delta t = 1$ s. The *rate* of heat input is 2500 J/s = 2500 W.

(c) $W_{\text{out}} = Q_{\text{in}} - |Q_{\text{out}}|$, so the heat output during $\Delta t = 1$ s is $|Q_{\text{out}}| = Q_{\text{in}} - W_{\text{out}} = 1500\ \text{J}$. The *rate* of heat output is thus 1500 J/s = 1500 W.