

46.20 What is the thermal efficiency of a reversible heat engine operating between a cold and hot reservoir with temperatures of $100^\circ F$ and $500^\circ F$, respectively?

- A. 42%
- B. 58%
- C. 71%
- D. 80%

For a heat engine to be reversible, it must be operating as a **Carnot Cycle**, which achieves the maximum theoretical efficiency and depends entirely upon the temperatures of the hot and cold reservoirs which heat is being transferred from and to. Be sure to use absolute temperatures when applying the efficiency formula for a Carnot cycle.

$$\eta_c = \frac{(T_H - T_L)}{T_H} = \frac{960^\circ R - 560^\circ R}{960^\circ R} = 42\%$$

Answer A

46.21 10,000cfm of atmospheric air is compressed adiabatically to 40psia by a 70% efficient compressor. What brake horsepower is required to drive the compressor?

- A. 370hp
- B. 530hp
- C. 760hp
- D. 1060hp

Look up **Adiabatic Compression** and use the formula provided.

$$\dot{W}_{comp} = \frac{\dot{m}P_i k}{(k-1)\rho_i \eta_c} \left[\left(\frac{P_e}{P_i} \right)^{1-\frac{1}{k}} - 1 \right]$$

The problem statement gives a volume flow rate rather than a mass flow rate, recall that mass flow rate is the product of density and volume flow rate.

$$\dot{m} = \rho Q$$

Substituting into the equation, the density cancels out. All other inputs are known. Substitute, and solve for \dot{W}_{comp} . Convert units to hp.

$$\dot{W}_{comp} = \frac{QP_i k}{(k-1)\eta_c} \left[\left(\frac{P_e}{P_i} \right)^{1-\frac{1}{k}} - 1 \right]$$