

CYCLE PERFORMANCE ACTIVITY

Names Key

Assume that a Carnot engine produces 20 kW of shaft power. The engine absorbs thermal energy at 927 °C and rejects thermal energy at 27 °C. Assume a fuel with heating value of 42 MJ/kg is burned to supply energy from the high temperature reservoir. Calculate the following:

a) What is the thermal efficiency of the engine?

Carnot Heat Engine $\eta = 1 - \frac{T_L}{T_H}$ $T_L = 300 \text{ K}$
 $T_H = 1200 \text{ K}$

$$\eta = 1 - \frac{300}{1200}$$

$$\eta = 0.75 = 75\%$$

b) What mass flow rate of fuel is required?

$$\text{Power} = \eta \dot{m}_{\text{fuel}} (-\Delta H_{\text{fuel}})$$

$$20,000 \text{ W} = (0.75) \left(42 \times 10^6 \frac{\text{J}}{\text{kg}} \right) \dot{m}_{\text{fuel}}$$

$$\dot{m} = 0.000635 \frac{\text{kg}}{\text{sec}} = 2.29 \text{ kg/hr} = 38.1 \frac{\text{gm}}{\text{min}}$$

c) What is the rate at which heat is rejected in the engine exhaust?

