# **Problem Set 8**

#### Problem 5.2

A Carnot engine receives 250 kJ s-1 of heat from a heat source reservoir at 525 °C and rejects heat to a heat-sink reservoir at 50 °C. What are the power developed and the heat ejected?

### Problem 5.6

Which is the more effective way to increase the thermal efficiency of a Carnot engine: to increase  $T_H$  with  $T_C$  constant, or to decrease  $T_C$  with  $T_H$  constant? For a real engine, which would be the more practical way?

## Problem 5.8

With respect to 1 kg of liquid water:

- (a) Initially at 0 °C, it is heated to 100 °C by contact with a heat reservoir at 100 °C. What is the entropy change of the water? What is the entropy change of the heat reservoir? What is  $\Delta S_{total}$ ?
- (b) Initially at 0 °C, it is first heated to 50 °C by contact with a heat reservoir at 50 °C, and then heated to 100 °C by contact with a heat reservoir at 100 °C. What is  $\Delta S_{total}$ ?
- (c) Explain how the water might be heated from 0 to 100 °C so that  $\Delta S_{total} = 0$ .

## Problem 5.10

An ideal gas,  $C_P = (7/2)R$ , is heated in a steady-flow heat exchanger from 70 to 190 °C by another stream of the same gas, which enters at 320 °C. The flow rates of the two streams are the same, and heat losses from the exchanger are negligible.

- (a) Calculate the molar entropy changes of the two gas streams for both parallel and countercurrent flow in the exchanger.
- (b) What is  $\Delta S_{total}$  in each case?
- (c) Repeat (a) and (b) for countercurrent flow if the heating stream enters at 200 °C.