10.213 Fall 1999

Problem 14 (due Friday, October 22nd)

A Carnot cycle removes 10 kW of heat from a 200 K thermal reservoir and exhausts heat to a 300 K thermal reservoir.

a) Calculate the coefficient of performance of the Carnot refrigerator.

b) Calculate the rate of work, $\frac{dW}{dt} = \dot{W}$ (in units of kW) required for by the Carnot refrigeration process.

c) Calculate the rate at which heat is exhausted to the hot (300 K) thermal reservoir.

Another reversible cycle removes 10 kW of heat from a 200 K thermal reservoir and exhausts 20 kW of heat to a 300 K thermal reservoir.

d) Calculate the rate of work, $\frac{dW}{dt} = \dot{W}$ (in units of kW) required for this refrigeration process.

e) Calculate the coefficient of performance for this second refrigerator.

A third reversible cycle removes 10 kW of heat from a 200 K thermal reservoir and exhausts 20 kW of heat to a 300 K thermal reservoir. However, this cycle does not produce or consume work. Instead, this cycle operates by using heat, $\frac{dQ_s}{dt} = \dot{Q}_s$, from a third thermal reservoir at temperature T_s.

f) Calculate $\dot{Q}_s$ (in units of kW) required for this second refrigeration process.

g) Find T_s in units of K.