## Practice Problems

**Problem 18-1:** Our bodies are a form of heat engine (chemical ‘heat’ energy in, mechanical energy out). We take in food (fuel) and through a series of complex metabolic processes transform the energy in the fuel to useful energy that allows us to conduct our daily activities. Calculate the maximum thermal efficiency of a human being with a normal body temperature (98.6°F). Assume that the human is in an environment at room temperature (70°F).

**Problem 18-2:** Consider a Carnot refrigerator operating with a low temperature (also known as the source temperature) of 40°F. For the high temperature (also known as the sink temperature) in the range 60°F < *TH* < 200°F. For this Carnot refrigerator construct a plot that shows the coefficient of performance (*y*-axis) vs. the temperature *difference* between the high-temperature and low-temperature reservoirs (*x*-axis).

**Problem 18-3:** Calculate the cooling capacity [kW] of a refrigerator with a coefficient of performances of 3.0 that is driven by a heat engine with thermal efficiency of 25%? The engine is receiving heat (fuel) at a rate of 600 kW.

## Preparatory Reading Questions

1. What are the units of specific entropy in the SI and English systems?
2. How is entropy change calculated for an incompressible substance? (page 222)
3. How is entropy change calculated for an ideal gas? (pages 222-223)
4. What are ideal gas P-v and T-v relationships for and isentropic expansion/compression?  
   (Assume constant specific heats. See pages 222-223)
5. Carnot efficiencies relate to ideal, completely reversible cycles. Reversible cycles are something that we can never achieve in the real-world. So, why do we spend time studying these types of cycles and processes?