## Practice Problems

Even though this is split up as four parts you should solve the whole assignment with a single EES file.

An isothermal source heat pump is utilizing the earth as an energy source. The heat pump uses R-134a as the working fluid. The earth’s temperature at the location of the source heat exchanger is relatively constant year-round. This results in a year-round standard evaporating temperature of at least 45 °F. Thermal energy from the condenser is available at 75 °F. The compressor has an isentropic efficiency of 80% and the pressure drops through the condenser and evaporator can be assumed to be negligible. The refrigerant leaves the condenser with 2 degrees of subcooling and it enters the compressor with 2 degrees of superheat. Under these conditions, the heat pump delivers 40,000 Btu/hr to the house.

**Part 1:**Determine the following

1. The mass flow rate of the refrigerant in the cycle [lbm/hr].
2. The power requirement of the compressor [hp].
3. The coefficient of performance of the heat pump cycle.

**Part 2:**  
In order to keep the living conditions in the house comfortable, the heat pump runs as described above for a total of 4 hours over the course of a day. If the cost of electricity is 0.05 $/kW-hr determine the following,

1. the number of kW-hr purchased from the electric utility per day to operate the heat pump
2. the cost of the energy required to heat the house with the heat pump for a day

**Part 3:**  
Now, consider the case where the required heat is provided to the house using an electric-resistance baseboard heater. The electric heater must supply the house with the same amount of energy as the heat pump to keep the living conditions comfortable in the house. Assume that the electric resistance heater has an efficiency of 100%, and calculate the following information,

1. the number of kW-hr purchased from the electric utility per day to operate the electric heater
2. the cost of the energy required to heat the house with the electric resistance heater for a day

**Part 4:**  
If your calculations are correct, you should discover that the cost of running the electric resistance heater is over ten times higher than the cost of running the heat pump.

1. If the cost to operate the heat pump is so much cheaper than electric resistance heat, why do you think heat pumps are not more prevalent in the home heating market?

## Answers

See the “Tips” for this homework for intermediate answers with a different refrigerant