Thermoelectricity: From Atoms to Systems

L4.3 Quiz

Answers

1) What is the net cooling power at the cold side of a thermoelectric element upon current injection? (*S*, *R*, and *K* are, respectively, the Seebeck coefficient, electric resistance, and thermal conductance of the element, T_C is the cold side temperature, ΔT is the net cooling, and *I* is the electric current.)
   a. $Q = ST_C I + IR^2 - K\Delta T$
   b. $Q = ST_C I - IR^2 - K\Delta T$
   c. $Q = -ST_C I - \frac{1}{2} IR^2 + K\Delta T$
   d. $Q = ST_C I - \frac{1}{2} IR^2 - K\Delta T$
   e. $Q = ST_C I + \frac{1}{2} IR^2 - K\Delta T$

2) What is the definition of the *coefficient of performance* of a cooler, and its theoretical maximum (Carnot limit) at the cold side? (*Q* is the cooling power at the cold side, and *W* is the work done for the cooling. T_C and T_H are the cold and hot side temperatures, respectively.)
   a. $COP = \frac{Q}{W}, COP_{\max} = \frac{T_C}{T_H - T_C}$
   b. $COP = \frac{Q}{W}, COP_{\max} = \frac{T_H}{T_H - T_C}$
   c. $COP = \frac{Q}{W}, COP_{\max} = \frac{T_H - T_C}{T_H}$
   d. $COP = \frac{Q}{W - Q}, COP_{\max} = \frac{T_C}{T_H - T_C}$
   e. $COP = \frac{W - Q}{Q}, COP_{\max} = \frac{T_H - T_C}{T_H}$

3) Why is there a maximum net cooling with varying electric current?
   a. Because the parasitic heat absorption from ambient increases quickly as the current increases.
   b. Because the Joule heating increases much faster than the Peltier cooling as the current increases.
   c. Because the Peltier heating increases much faster than the Peltier cooling as the current increases.
   d. Because the heat conduction from the hot side increases much faster than the Peltier cooling as the current increases.
   e. Because the Peltier cooling is reduced and becomes heating as the current increases.