ANSWERS: Quiz: Week 2 Lecture 4
Thermoelectrics from Atoms to Systems
Mark Lundstrom, nanoHUB-U Fall 2013

Answer the **five questions** below by choosing the **one, best answer**.

1) What type of distribution of channels, $M(E)$, makes the electronic thermal conductivity, k_e zero?

a) One that is uniform in energy.
b) One that increases linearly with energy from the band edge.
c) One that increases as the square of energy from the band edge.
d) One that increases as the cube of energy from the band edge.
e) One that is a delta function in energy.

2) Consider a thin semiconductor sheet with thickness, *t*. How do we determine whether we should treat electrons in the sheet as 2D entities rather than as 3D entities?

a) The thickness of the sheet should be much bigger than the Debye length.
b) The thickness of the sheet should be much smaller than the Debye length.
c) The thickness of the sheet should be bigger than the electron de Broglie wavelength.
d) The thickness of the sheet should be smaller than the electron de Broglie wavelength.
e) The thickness of the sheet should be less than 0.1 nm.

3) For a given location of the Fermi level, the magnitude of the Seebeck coefficient is larger in 3D than in 1D. Why?

a) Because the channels are more spread out in energy in 3D, so the average current flows at an energy that is further from the Fermi level.
b) Because the channels are less spread out in energy in 3D, so the average current flows at an energy that is closer to the Fermi level.
c) Because there are more channels in 3D.
d) Because there are fewer channels in 3D.
e) Because the Fermi window is wider in 3D.

(continued on next page)

Quiz: Week 2 Lecture 4 (continued)

4) Which of the following is true about the location of the Fermi level to maximize the power factor in an n-type semiconductor?

a) It is higher in 1D than in 2D and higher in 2D than in 3D.
b) It is lower in 1D than in 2D and lower in 2D than in 3D.
c) It is the same in 1D, 2D, and 3D.
d) It is the same in 1D and 2D, but higher in 3D.
e) It is the same in 2D and 3D, but lower in 1D.

5) To treat a ballistic thermionic device under low bias, how should the expressions for the four thermoelectric transport coefficients for bulk semiconductors be modified?

a) No modification necessary – the TE coefficients for the thermionic device are the same.
b) Replace the actual mean-free-path by the thickness of the barrier.
c) Let the mobility approach infinity.
d) Let the thickness of the barrier approach zero.
e) Replace the actual temperature by the Debye temperature.

End of quiz. This quiz contains 5 questions.