

Quiz Answers: Week 3
ECE 656: Electronic Conduction In Semiconductors
Mark Lundstrom
Purdue University, Fall 2013

Lecture 6 Quiz :

- 1) Which of the following is true ionized impurity scattering?
 - a) It is elastic and isotropic
 - b) It is elastic and anisotropic**
 - c) It is inelastic and isotropic
 - d) It is inelastic and anisotropic

- 2) What is the Debye length?
 - a) The average distance an electron diffuses before recombining with a hole.
 - b) The average distance between ionized impurity scattering events.
 - c) The average distance over which charge perturbations decay to zero.**
 - d) The length of the depletion region around an ionized impurity.
 - e) The length of the accumulation region around an ionized impurity.

- 3) How does the II momentum relaxation time vary with energy?
 - a) As $(E - E_c)^{1/2}$.
 - b) As $(E - E_c)^{3/2}$.**
 - c) As $(E - E_c)^0$.
 - d) As $(E - E_c)^{-1/2}$.
 - e) As $(E - E_c)^{-3/2}$.

continued on next page

- 4) Which of the following statements is true about the characteristics times for II scattering?
- The scattering time is greater than the momentum relaxation time, but less than the energy relaxation rate.
 - The scattering time is less than the momentum relaxation time, and less than the energy relaxation rate.**
 - The scattering time and the momentum relaxation times are equal and less than the energy relaxation time.
 - The scattering time and the momentum relaxation times are equal and greater than the energy relaxation time.
 - The scattering time, the momentum relaxation time, and the energy relaxation time are all equal.
- 5) Consider a semiconductor that is so heavily doped that degenerate carrier statistics are needed. How does the non-degenerate expression for the screening length compare to the degenerate expression?
- The non-degenerate expression gives a longer screening length.
 - The non-degenerate expression gives a shorter screening length.**
 - The non-degenerate expression gives the same screening length.
 - The answer depends on how heavily doped the semiconductor is.
 - The answer depends on the sign of the charge perturbation.

Lecture 7 Quiz:

- 1) What is the parameter, b , the impact factor?
- Another name for the Debye length?
 - The average spacing of dopants.
 - The minimum distance between the carrier and the ionized impurity in a scattering event.**
 - The maximum distance between the carrier and the ionized impurity in a scattering event.
 - The radius of the ionized impurity .
- 2) What is main difference between the Brooks-Herring (BH) and Conwell-Weisskopf (CW) treatments of II scattering?
- BH assumes a screened Coulomb potential and CW an unscreened Coulomb potential.**
 - BH uses Fermi's Golden Rule to compute the transition rate, and CW does not.
 - CW uses Fermi's Golden Rule to compute the transition rate, and BH does not.
 - BH assumes Fermi-Dirac statistics and CW does not.
 - CW assumes Fermi-Dirac statistics and BH does not.

continued on next page

- 3) Which of the following is true of the Brooks-Herring approach to ionized impurity scattering but **not true** about the Conwell-Weisskopf approach?
- a) It strongly favors small angle scattering.
 - b) It assumes that the scattering potential is screened.**
 - c) It assumes that scattering from different impurities is phase incoherent.
 - d) It is elastic.
 - e) It gets weaker as the energy of the carrier increases
- 4) How does one decide whether to use the BH approach or the CW approach?
- a) Use CW when the maximum impact parameter is greater than the Debye length.
 - b) Use CW when the maximum impact parameter is less than the Debye length.**
 - c) Use CW for low temperatures and BH for high temperatures.
 - d) Use CW for high temperatures and BH for low temperatures.
 - e) Use CW for electrons and BH for holes.
- 5) What is (are) key limitations for the Fermi's Golden Rule treatment of II scattering?
- a) It assumes parabolic energy bands.
 - b) It assumes low temperatures.
 - c) It assumes that the scattering rate does not depend on the sign of the II charge.**
 - d) All of the above.
 - e) None of the above.