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Week 2 Quiz ANSWERS: Carrier Properties
ECE 305: Semiconductor Devices
Mark Lundstrom
Purdue University, Spring 2015

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

1) To treat electrons in the conduction band as classical particles, what must we do?
   a) Replace the charge on an electron in vacuum with an effective charge.
   b) **Replace the rest mass of an electron in vacuum with an effective mass.**
   c) Include relativistic effects.
   d) Increase the temperature to the melting point of the semiconductor.
   e) Decrease the temperature to zero.

2) Which of the following is true about an intrinsic semiconductor?
   a) Electron concentration, *n*, equals hole concentration, *p*.
   b) The concentration of electrons is n_i.
   c) The concentration of holes is n_i.
   d) The concentration of electrons and holes increases with increasing temperature.
   e) All of the above.

3) Which of the following atoms would be an n-type dopant in Si?
   a) Ga (a column III) element)
   b) Si (a column IV element)
   c) As (a column V element)
   d) O (a column VI element)
   e) F (a column VII element)

4) Where is a donor level located on an energy band diagram?
   a) Far above E_C
   b) A little below E_C
   c) About midway between E_C and E_V
   d) A little above E_V
   e) Way below E_V

5) What is a typical donor binding energy for a donor in Si?
   a) 10 eV
   b) 1 eV
   c) 0.5 eV
   d) 0.05 eV
   e) 0.005 eV

6) What does the quantity, $g_C(E)dE$ represent?
   a) The number of electrons in the conduction band between *E* and *E* + *dE*
   b) The number of states in the conduction band between *E* and *E* + *dE*
   c) The number of donor states between *E* and *E* + *dE*
   d) The number of acceptor states between *E* and *E* + *dE*
   e) The number of Si atoms with energies between *E* and *E* + *dE*

7) Which of the following is the Fermi function?
   a) $f = 1/\left(1 - e^{(E-E_F)/k_BT}\right)$
   b) $f = 1/\left(1 + e^{(E-E_F)/k_BT}\right)$
   c) $f = 1/\left(1 - e^{(E+E_F)/k_BT}\right)$
   d) $f = 1/\left(1 + e^{(E+E_F)/k_BT}\right)$
   e) $f = 1/\left(1 - e^{(E_F-E)/k_BT}\right)$

8) Assume that the Fermi level is near the valence band. Which of the following is true?
   a) $n = p = n_i$
   b) $n > p, n >> n_i$
   c) $p > n, p >> n_i$
   d) $n >> n_i$
   e) $n + p = n_i$