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**Week 2 Quiz: Carrier Properties**  
**ECE 305: Semiconductor Devices**  
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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?
- 10 eV
  - 1 eV
  - 0.5 eV
  - 0.05 eV
  - 0.005 eV
- 6) What does the quantity,  $g_c(E)dE$  represent?
- The number of electrons in the conduction band between  $E$  and  $E + dE$
  - The number of states in the conduction band between  $E$  and  $E + dE$
  - The number of donor states between  $E$  and  $E + dE$
  - The number of acceptor states between  $E$  and  $E + dE$
  - The number of Si atoms with energies between  $E$  and  $E + dE$
- 7) Which of the following is the Fermi function?
- $f = 1 / \left( 1 - e^{(E-E_F)/k_B T} \right)$
  - $f = 1 / \left( 1 + e^{(E-E_F)/k_B T} \right)$
  - $f = 1 / \left( 1 - e^{(E+E_F)/k_B T} \right)$
  - $f = 1 / \left( 1 + e^{(E+E_F)/k_B T} \right)$
  - $f = 1 / \left( 1 - e^{(E_F-E)/k_B T} \right)$
- 8) Assume that the Fermi level is near the valence band. Which of the following is true?
- $n = p = n_i$
  - $n > p, n \gg n_i$
  - $p > n, p \gg n_i$
  - $n \gg n_i$
  - $n + p = n_i$