Quiz Answers: Week 2
ECE 656: Electronic Conduction In Semiconductors
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1) The 1D DOS is given by $D_{1D} = 2/(\pi\hbar\upsilon)$. What are the units of this expression?
   a) Joules^{-1}.
   b) Joules^{-2}.
   c) Joules^{-1} m^{-1}.
   d) Joules^{-1} m^{-2}.
   e) Joules^{-2} m^{-1}.

2) The 1D DOS is given by: $D_{1D} = 2/(\pi\hbar\upsilon)$. What band structure does this apply to?
   a) Parabolic.
   b) Spherical.
   c) Ellipsoidal.
   d) Linear.
   e) Any band structure.

3) A common way to describe a non-parabolic conduction band is $E(k)\left[1+\alpha E(k)\right] = \hbar^2 k^2 / \left[2m^*(0)\right]$. What does non-parabolicity ($\alpha > 0$) do to the density of state in k-space and energy space?

   a) Increases *DOS*(*k*) and increases *DOS*(*E*).
   b) Increases *DOS*(*k*) and decreases *DOS*(*E*).
   c) Decreases *DOS*(*k*) and increases *DOS*(*E*).
   d) Decreases *DOS*(*k*) and decreases *DOS*(*E*).
   e) Leaves *DOS*(*k*) unchanged and increases *DOS*(*E*).

4) What is the quantity, $(1/A)\sum_{\vec{k}} \delta(E - E_k)$?

   a) The number of electrons.
   b) The density of electrons per cm^2.
   c) The density-of-states in k-space.
   d) The density-of-states in energy-space.
   e) Unity.

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5) Very often, it suffices to know the DOS only near the bottom of the conduction band and the top of the valence band. Why?
   a) Because the DOS at higher (or lower) energies can be obtained by extrapolation of the DOS near the band edges.
   b) Because the Fermi function ensures that states well above E_C are always empty and that states well below E_V are always full.
   c) Because the bands become parabolic well above E_C and well below E_V.
   d) All of the above.
   e) None of the above.

6) Which of the following is generally true of the characteristic times? (Scattering time, τ, momentum relaxation time, τ_m, and energy relaxation time, τ_E.)
   a) $\tau > \tau_m > \tau_E$.
   b) $\tau > \tau_m < \tau_E$.
   c) $\tau < \tau_m > \tau_E$.
   d) $\tau < \tau_m < \tau_E$.
   e) $\tau \approx \tau_m \approx \tau_E$.

7) Which of the following assumptions does Fermi's Golden Rule make?
   a) Elastic scattering and infrequent scattering.
   b) Inelastic scattering and infrequent scattering.
   c) Weak scattering and infrequent scattering.
   d) Time independent scattering and weak scattering.
   e) Time dependent scattering and weak scattering.

8) When we write $\vec{p}\,' = \vec{p} + \hbar\vec{q}$, what are $\vec{p}\,'$ and $\vec{q}$?
   a) The quantity, $\vec{p}\,'$, is the final momentum of the electron and $\vec{q}$ is a Fourier component of the scattering potential.
   b) The quantity, $\vec{p}\,'$, is the final momentum of the electron and $\vec{q}$ is the momentum of the scattering potential.
   c) The quantity, $\vec{p}\,'$, is the final crystal momentum of the electron and $\vec{q}$ is a Fourier component of the scattering potential.
   d) The quantity, $\vec{p}\,'$, is the final energy of the electron and $\vec{q}$ is a Fourier component of the scattering potential.
   e) The quantity, $\vec{p}\,'$, is the final crystal momentum of the electron and $\vec{q}$ is the initial momentum.

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9) For isotropic scattering, how is the scattering rate related to the density-of-states? (A subscript, "i" refers to the initial state and a subscript, "f" to the final state.)

a) $\tau(E_i) \propto D(E_i)$.

b) $\tau(E_i) \propto D(E_f)$.

c) $1/\tau(E_i) \propto D(E_i)$.

d) $1/\tau(E_i) \propto D(E_f)$**.**

e) $1/\tau(E_i) \propto D(E_i + E_f)$.

10) If the transition rate, $S(\vec{p},\vec{p}')$, has a term, $\delta(E' - E \mp \hbar\omega)$, which of the following is true ($\hbar\omega > 0$)?

a) The scattering is isotropic and elastic.
b) The scattering is isotropic and inelastic.
c) The scattering is anisotropic and inelastic.
d) The scattering is inelastic.
e) The scattering is anisotropic.