

**Week 5 Lecture 11 Quiz:
Scattering in 1D, 2D, and 3D**

ECE 656: Electronic Conduction In Semiconductors

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Student's name: _____

Answer the **multiple choice questions** below by choosing the **one, best answer**. Then **ask a question** about the lecture.

- 1) ADP scattering in 3D is proportional to the 3D density of final states. ADP scattering in 2D is proportional to the 2D density of final states, but something else changes. What is it?
 - a) We must be careful about momentum conservation in the direction of confinement.
 - b) We must be careful about momentum conservation in the plane.
 - c) We must be careful about energy conservation in the direction of confinement..
 - d) We must be careful about energy conservation in the plane.
 - e) All of the above.

- 2) What is a "form factor"?
 - a) Another name for the overlap integral.
 - b) Another name for the shape of the confined wavefunction.
 - c) An integral that depends on the shape of the confined wavefunction and that modifies momentum conservation for confined carriers.
 - d) An integral that depends on the shape of the confined wavefunction and that modifies energy conservation for confined carriers..
 - e) The factor used to normalize the wavefunction of the confined carrier to 1.

- 3) ADP scattering can be expressed in power law form, $\tau(E) = \tau_0 (E/k_B T)^s$. What is the characteristic exponent, s , in 3D, 2D, and 1D for a **parabolic band** semiconductor?
 - a) $s_{3D} = 3/2, s_{2D} = 1, s_{1D} = 1/2$.
 - b) $s_{3D} = 3, s_{2D} = 2, s_{1D} = 1$.
 - c) $s_{3D} = 3/2, s_{2D} = 1/2, s_{1D} = -1/2$.
 - d) $s_{3D} = +1/2, s_{2D} = 0, s_{1D} = -1/2$.
 - e) $s_{3D} = -1/2, s_{2D} = 0, s_{1D} = +1/2$.

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- 4) ADP scattering can be expressed in power law form, $\tau(E) = \tau_0 (E/k_B T)^s$. What is the characteristic exponent, s , for **graphene**?
- a) $s = 1/2$.
 - b) $s = 0$.
 - c) $s = -1/2$.
 - d) $s = -1$.
 - e) $s = -3/2$.
- 5) The 2D density of states for parabolic energy bands is independent of energy, but for electrons in the 2D quantum well, the scattering rate generally increases with energy. Why?
- a) Because of conduction non-parabolicity.
 - b) Because of carrier degeneracy.
 - c) Because the electron-phonon coupling parameter is enhanced.
 - d) Because overlap integral increase with quantum confinement.
 - e) Because inter-subband scattering can occur in addition to intra-subband scattering.
- 6) What question do you have about this lecture?

Turn in to Prof. Lundstrom in class on Friday.