Week 3 Lecture 9 Quiz:
Phonon Scattering: Part II

ECE 656: Electronic Conduction In Semiconductors

Mark Lundstrom
Purdue University, Fall 2013

(Revised 9/13/13)

Student's name: ________________________________

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

1) How does the acoustic phonon (sound) velocity of a material, υ_S, depend on the density (kg/m^3) of the material?
   a) The sound velocity is proportional to the square root of the density.
   b) The sound velocity is proportional to one over the square root of the density.
   c) The sound velocity is proportional to the density.
   d) The sound velocity is proportional to one over the density..
   e) The sound velocity is independent of the density.

2) If the change in momentum from the initial state for which the magnitude of crystal momentum is $p = \hbar k$ to the scattered state with $p' = \hbar k'$ is $\hbar\beta$, what type of scattering does the relation $0 < \hbar\beta < 2p$ imply?
   a) Elastic scattering.
   b) Inelastic scattering.
   c) Isotropic scattering.
   d) Anisotropic scattering.
   e) Inelastic and anisotropic scattering.

3) Why is it that optical phonon scattering requires the initial kinetic energy to be greater than the optical phonon energy?

   a) So that phonon absorption does not occur.
   b) So that that phonon absorption is greater than phonon emission.
   c) So that there are final states to scatter to.
   d) So that that stimulated phonon emission equals spontaneous phonon emission.
   e) None of the above.

continued on next page

4) In the expression for the transition rate,

$$S(\vec{p},\vec{p}\,') = \frac{2\pi}{\hbar}\left|K_\beta\right|^2 \left|A_\beta\right|^2 \delta_{\vec{p}\,',\vec{p}\pm\hbar\vec{\beta}}\,\delta\left(E' - E \mp \hbar\omega\right)$$

what does $\left|A_\beta\right|^2$ represent?

a) The electron-phonon coupling constant.
b) The matrix element (magnitude squared) for scattering.
c) The magnitude squared of the overlap integral.
d) The magnitude squared of the lattice vibration.
e) The scattering rate.

5) When we write $\left|A_\beta\right|^2 \rightarrow \frac{\hbar}{2\rho\Omega\omega}\left(N_\omega + 1/2 \mp 1/2\right)$ what are we doing?

a) Changing a classical expression to a quantum mechanical expression.
b) Properly accounting for stimulated absorption.
c) Properly accounting for stimulated emission.
d) Properly accounting for spontaneous emission.
e) All of the above.

6) What question do you have about this lecture?

Turn in to Prof. Lundstrom in class on Friday.