Quiz Answers: Week 4
ECE 656: Electronic Conduction In Semiconductors

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Lecture 8 Quiz :

1) Compare the typical acoustic phonon (sound) velocity, υ_S, to the average thermal velocity of electrons, υ_{th}. Which of the following is true?
   a) $\upsilon_S \approx \upsilon_{th}$.
   b) $\upsilon_S < \upsilon_{th}$.
   c) $\upsilon_S << \upsilon_{th}$.
   d) $\upsilon_S > \upsilon_{th}$.
   e) $\upsilon_S >> \upsilon_{th}$.

2) Comparing optical and acoustic phonons near the center of the Brillouin zone, which of the following is true?
   a) Optical phonon velocity **much less** than acoustic phonon velocity and optical phonon energy **much less** than acoustic phonon energy.
   b) Optical phonon velocity much less than acoustic phonon velocity and optical phonon energy much greater than acoustic phonon energy.
   c) Optical phonon velocity **much greater** than acoustic phonon velocity and optical phonon energy **much less** than acoustic phonon energy..
   d) Optical phonon velocity **much greater** than acoustic phonon velocity and optical phonon energy **much greater** than acoustic phonon energy..
   e) Optical phonon velocity **roughly equal** to acoustic phonon velocity and optical phonon energy **roughly equal** to acoustic phonon energy..

3) Which phonons are most responsible for **intravalley** scattering?

   a) Longitudinal modes near the zone center.
   b) Transverse modes near the zone center.
   c) Longitudinal modes near the zone boundary.
   d) Transverse modes near the zone boundary.
   e) Both longitudinal and transverse modes near the zone center.

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4) What is "deformation potential" scattering?

   a) Scattering by acoustic phonons that is due to the change in bandgap (or band edge) due to a change in lattice spacing.
   b) Scattering by optical phonons that is due to the change in bandgap (or band edge) due to a change in lattice spacing.
   c) Scattering by either acoustic or optical phonons that is due to the change in bandgap (or band edge) due to a change in lattice spacing.
   d) Scattering by defects in the crystal.
   e) Scattering by an electrostatic dipole in the crystal.
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5) Which of the following scattering mechanisms occur in GaAs but not in Si?
   a) Acoustic deformation potential scattering.
   b) Optical deformation potential scattering.
   c) Ionized impurity scattering.
   d) Polar optical phonon scattering.
   e) None of the above.

Lecture 9 Quiz:

1) How does the acoustic phonon (sound) velocity of a material, v_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.

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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.

4) In the expression for the transition rate,

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

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 $\left|A_\beta\right|^2\rightarrow\frac{\hbar}{2\rho\Omega\omega}\left(N_\omega+1/2\mp1/2\right)$ 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.