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Week 4 Quiz: Equilibrium Carrier Concentrations
ECE 305: Semiconductor Devices

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Answer the **multiple choice questions** below by choosing the **one, best answer**.

- 1) Velocity, mobility, and electric field are related by $v = \mu E$. What are the units of mobility?
 - a) cm/s
 - b) cm^2/s
 - c) $\text{cm}^2\text{-V}/\text{s}$
 - d) $\text{cm}^2/(\text{V}\text{-s})$
 - e) $\text{cm}^2\text{-V}\text{-s}$

- 2) Electric field and current density are related by $E = \rho J$. What are the units of resistivity?
 - a) Siemens/m.
 - b) Siemens-m.
 - c) Ohms/m.
 - d) Ohm-m.
 - e) Ohms/Siemens

- 3) How do we determine the electric field vs. position, x , from an energy band diagram?
 - a) The electric field is $E_C(x)$.
 - b) The electric field is $E_V(x)$.
 - c) The electric field is $E_i(x)$.
 - d) The electric field is obtained by flipping $E_C(x)$ upside down.
 - e) The electric field is the slope of $E_C(x)$.

- 4) The quantity, $-\mu_n E$ represents:
 - a) The instantaneous velocity at which electron drift in an electric field.
 - b) The average velocity at which electron drift in an electric field.
 - c) The average power dissipated in a semiconductor under bias.
 - d) The average velocity at which electrons diffuse.
 - e) The thermal velocity of electrons.

ECE-305 Week 4 Quiz continued:

- 5) As the doping density of a semiconductor increases, the mobility generally:
- a) Stays the same
 - b) Increases.
 - c) Decreases.
 - d) First increases, then decreases.
 - e) First decreases, then increases.
- 6) At high temperatures, the mobility decreases because:
- a) Lattice vibrations scatter the electrons.
 - b) The intrinsic carrier concentration increases.
 - c) The semiconductor crystal begins to melt.
 - d) The Einstein relation begins to break down
 - e) Because of Mathiessen's rule
- 7) To decrease the resistivity of a semiconductor, we can:
- a) Increase the carrier density.
 - b) Decrease the mobility.
 - c) Increase the electric field.
 - d) Increase the cross-sectional area of the resistor.
 - e) Decrease the length of the resistor.
- 8) The Einstein relation relates what two quantities?
- a) The diffusion coefficient and the minority carrier lifetime.
 - b) The diffusion length and the minority carrier lifetime.
 - c) The hole and electron mobilities.
 - d) The hole and electron diffusion coefficients.
 - e) The mobility and the diffusion coefficient.
- 9) Under what conditions is the Fermi level constant?
- a) For an intrinsic semiconductor.
 - b) For an extrinsic semiconductor.
 - c) In the freezeout regime.
 - d) In equilibrium for any semiconductor.
 - e) Where there is a temperature gradient.
- 10) Which of the following is NOT a recombination mechanism?
- a) Shockley-Read-Hall (SRH).
 - b) Auger.
 - c) Radiative.
 - c) Band-to-band.
 - d) Impact ionization.
 - e) R-G center.

ECE-305 Week 4 Quiz continued:

- 11) In the equation, $R = \Delta n_p / \tau_n$, what is the meaning of the parameter, τ_n ?
- a) It is the majority electron lifetime.
 - b) It is the minority electron lifetime.
 - c) It is the majority electron diffusion length.
 - d) It is the minority electron diffusion length.
 - e) It is the transit time of a minority electron across a p-type region.