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Week 7 Quiz: PN Junction Electrostatics and Ideal Diode Equation
ECE 305: Semiconductor Devices
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Answer the **multiple choice questions** below by choosing the **one, best answer**.

1) Which of the following is the Poisson equation for the depleted N-side of a PN junction?
   a) $dV/dx = +qN_D/(K_S\varepsilon_0)$.
   b) $dV/dx = -qN_D/(K_S\varepsilon_0)$.
   c) $dV/dx = 0$.
   d) $d\mathcal{E}/dx = +qN_D/(K_S\varepsilon_0)$.
   e) $d\mathcal{E}/dx = -qN_D/(K_S\varepsilon_0)$.

2) Which of the following statements about a one-sided PN junction $N_D >> N_A$ is true?
   a) The peak electric field in the depletion region varies as $\sqrt{V_{bi}}$ and $\sqrt{N_A}$.
   b) The peak electric field in the depletion region varies as $1/\sqrt{V_{bi}}$ and $\sqrt{N_A}$.
   c) The peak electric field in the depletion region varies as $\sqrt{V_{bi}}$ and $1/\sqrt{N_A}$.
   d) The peak electric field in the depletion region varies as $1/\sqrt{V_{bi}}$ and $1/\sqrt{N_A}$.
   e) The peak electric field in the depletion region varies as V_{bi} and $\sqrt{N_A}$.

3) Which of the following statements about a one-sided PN junction $N_D >> N_A$ is true?
   a) The depletion region width varies as $\sqrt{V_{bi}}$ and $\sqrt{N_A}$.
   b) The depletion region width varies as $1/\sqrt{V_{bi}}$ and $\sqrt{N_A}$..
   c) The depletion region width varies as $\sqrt{V_{bi}}$ and $1/\sqrt{N_A}$.
   d) The depletion region width varies as $1/\sqrt{V_{bi}}$ and $1/\sqrt{N_A}$.
   e) The depletion region width varies as V_{bi} and $\sqrt{N_A}$.

4) What is the physical meaning of the area under $\mathcal{E}(x)$ vs. x?
   a) It is the total doping density in the transition region.
   b) It is equal to the bandgap of the semiconductor.
   c) It is the net space-charge density in the transition region.
   d) It is the net dipole moment of the junction.
   e) It is the built-in potential of the junction.

5) Which of the following is true about the energy barrier that keeps electrons on the N-side and holes on the P-side?
   a) It increases under forward bias and decreases under reverse bias.
   b) It increases under forward bias and increases under reverse bias.
   c) It decreases under forward bias and decreases under reverse bias.
   d) It decreases under forward bias and increases under reverse bias.
   e) It decreases under forward bias and does not change under reverse bias.

6) What is the mathematical statement of the "law of the junction"?
   a) $np = n_i^2$.
   b) $np = n_i^2 e^{qV_A/k_BT}$.
   c) $np = n_i^2 e^{qV_A/2k_BT}$.
   d) $np = n_i^2 e^{qV_{bi}/k_BT}$.
   e) $np = n_i^2 e^{qV_{bi}/2k_BT}$.

7) For an ideal diode, the **forward bias** ($V_A > 0$) current is proportional to e^{qV_A/nk_BT}. What is the value of *n* for an ideal diode?
   a) $n = 0$.
   b) $n = 0.5$.
   c) $n = 1.0$.
   d) $n = 1.5$.
   e) $n = 2.0$.

8) For an ideal diode, the **reverse bias** ($V_A < 0$) current is proportional to what?
   a) $-V_A$.
   b) $\sqrt{-V_A}$.
   c) $\left(-V_A\right)^{1/3}$.
   d) $\left(-V_A\right)^2$.
   e) $\left(-V_A\right)^0$.