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Courses » Semiconductor Devices and Circuits

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Unit 5 - Week 4 : Recombination-Generation, Charge Transport and Continuity Equation

Assignment 4

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2018-09-05, 23:59 IST.

1) What do you understand by the term "diffusion length" of an electron inside a p-type Si? *1 point*

- The distance between two Si atoms in the crystal structure
- The instantaneous distance a free electron travels between two successive collisions.
- The average distance a free electron travels between two successive collisions.
- The average distance a free electron travels before recombining with a hole.

No, the answer is incorrect.
Score: 0

Accepted Answers:
The average distance a free electron travels before recombining with a hole.

2) Which of the following defines a thermal equilibrium completely? *1 point*

- Detailed balance of individual processes.
- Steady-state condition, but not the detailed balance of individual processes.
- Recombination rate = generation rate.
- Total recombination = 0.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Detailed balance of individual processes.

3) The minority carrier life-time of electrons in a certain semiconductor is $9e-12\,s$. The electron mobility is $350\,cm^2/V.s$. If the thermal voltage is $25\,mV$, the diffusion length of electrons is ________ μm. (Fill in the gap) *1 point*

No, the answer is incorrect.
Score: 0

Accepted Answers:
8.9

4) An intrinsic Si wafer is doped with 10^{16} $/cc$ donors. 10^{12} photons/sec light is irradiated on the Si per cm^3 volume. Assume each photon generates one electron-hole pair. Under this light illumination, location of the Fermi levels inside Si with respect to the intrinsic Fermi level are ______ eV and _______ eV as viewed by electrons and holes respectively. (Fill in the gaps) Assume the intrinsic carrier concentration $= 10^{10}$ $/cc$ and thermal voltage $= 26\,mV$. ***1 point***

- 0.36,   0.36
- 0.36,   0.12
- 0.12,   0.12
- 0.12,   0.36

No, the answer is incorrect.
Score: 0

Accepted Answers:
0.36,   0.12

5) An intrinsic Si wafer is doped with 10^{16} $/cc$ arsenic atoms. If a small amplitude low frequency alternating voltage of v_{in} is applied across a block of this doped Si, a current i_{in} flows through. Assume the block is a cube of side $5\ \mu m$ and all the dopant atoms are ionized. Find $\frac{\partial v_{in}}{\partial i_{in}}$. Assume, intrinsic carrier concentration in Si $= 10^{10}$ $/cc$, electron mobility $= 1000\,cm^2/V.s$ and hole mobility $= 350\,cm^2/V.s$. ***1 point***

- 5.83 kΩ
- 3.57 kΩ
- 1.25 kΩ
- 0.13 Ω

No, the answer is incorrect.
Score: 0

Accepted Answers:
1.25 kΩ

6) What is the location of the traps inside the band-gap that produces the most efficient trap-assisted recombination? ***1 point***
Assume that the degeneracy factor of the trap = 1 and the minority carrier lifetimes of holes and electrons are equal.

- Very close to the conduction-band.
- Near the middle of the band-gap.
- Very close to the valence-band.
- It is independent of the position of the traps inside the band-gap.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Near the middle of the band-gap.

7) When there are multiple recombination mechanisms present, how do you determine the effective minority carrier lifetime for all processes combined? ***1 point***

- Add the lifetimes of individual processes.
- Multiply the lifetimes of individual processes.
- Add the inverse of the lifetimes of individual processes and then take the inverse of the sum.
- Take the maximum of lifetimes of individual processes.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Add the inverse of the lifetimes of individual processes and then take the inverse of the sum.

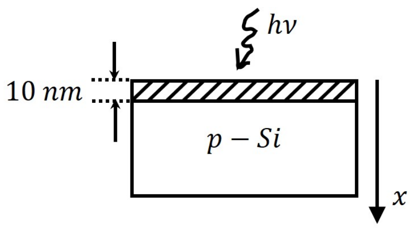
8) Assume the following parameters for a Si wafer: ***1 point***
Mean free time of hole, $\tau_p = 0.1\,ps$.
Electron rest mass, $m_0 = 9.1e - 31\,kg$.
Hole effective mass, $m_p^* = 0.39m_0$.
Find the hole drift velocity at field, $\xi = 1e3\,V/cm$.

- 4.51 e5 cm/s
- 1.76 e5 cm/s
- 2.1 e7 cm/s
- 1.02 e6 cm/s

No, the answer is incorrect.
Score: 0

Accepted Answers:
4.51 e5 cm/s

9) Assume a p-type Si sample has the following parameters at room temperature $(300\,K)$: ***1 point***
$N_A = 10^{17}\,/cc,\ \mu_n = 300\,cm^2/V.s,\ \tau_n = 1\,\mu s$.
The sample is uniformly illuminated with light, as shown in the following figure, resulting in an optical generation rate $G_L = 10^{24}\,cm^{-3}s^{-1}$, but all the incoming photons are absorbed in a thin layer of $10\,nm$ at the surface. Find the steady-state excess electron concentration at $x = 1\,\mu m$. Assume the sample extends to infinity along the x-axis.



- 1.2 e10 /cc
- 0
- 5.1 e17 /cc
- 3.5 e14 /cc

No, the answer is incorrect.
Score: 0

Accepted Answers:
3.5 e14 /cc

10)Consider the sample given in the previous problem (question no. 9) with the following changes: ***0 points***

Assume that the semiconductor is only $5\ \mu m$ long instead of infinitely extended.
Also assume that there is an "ideal ohmic contact" at $x = L = 5\ \mu m$, which always enforces equilibrium condition.
Now find the steady-state excess electron concentration at $x = 1\ \mu m$.

- 1.2 e10 /cc
- 0
- 5.1 e17 /cc
- 3.5 e14 /cc

No, the answer is incorrect.
Score: 0

Accepted Answers:
5.1 e17 /cc

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