Life of a Particle : Quiz on Semi-conductor Physics

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1 Conductivity of intrinsic silicon

Calculate the voltage that should be applied on a rectangular plate of intrinsic (undoped) silicon at 300 K in order to have a current of 100 nA.
The cross section of the plate is 10 $\mu m \times 50\ \mu m$ and its length is 1 mm.

2 Energy bands and acceptors

A) Sketch the band structure of an intrinsic, a p-doped and n-doped semi-conductor. Indicate for each the Fermi level.

B) Why is this doping n and p called donor and acceptors respectively?

C) A p-doped silicon plate is put next to an n-doped one. Sketch the density of charges, the electric field, the electrostatic potential and the band structure with the Fermi level as a function of the x coordinate:

1. when the two stabs are apart from each other
2. when the stabs touch

3 Conductivity of doped silicon

The silicon plate of exercice 1 is now doped with donors of different densities:

1. $N_D = 10^9\ \text{cm}^{-3}$
2. $N_D = 10^12\ \text{cm}^{-3}$
3. $N_D = 10^15\ \text{cm}^{-3}$

Which voltages must be applied to achieve the same current?