1. A sample of silicon is doped with $N_d = 1.1 \times 10^{13}$ cm$^{-3}$ and $N_a = 1 \times 10^{13}$ cm$^{-3}$.
   a) Which carrier is the majority carrier?
   b) What type is the silicon (n or p)?
   c) Find the electron and hole concentration at room temperature.

2. A sample of silicon is doped with $N_d = 2 \times 10^{16}$ cm$^{-3}$.
   a) What is the electron concentration and mobility?
   b) We want to dope to the electron concentration of $1 \times 10^{16}$ cm$^{-3}$. What is the additional dopant type and concentration? What is the new electron mobility?

3. Given an n-type ion-implanted layer with thickness $t = 1$ μm and average doping concentration $N_d = 10^{17}$ cm$^{-3}$.
   a) What is the sheet resistance?
   b) What is the resistance of the layout shown below? (Assume that the contact regions each contribute 0.65 squares.)

   ![Layout Diagram]

   L = 150 μm
   W = 3 μm

   c) By adding additional dopants, we make a new n-type ion-implanted resistor with an average doping concentration $N_{d1} = 2 \times 10^{17}$ cm$^{-3}$ over the depth $0 < x < 0.25$ μm and $N_{d2} = 10^{17}$ cm$^{-3}$ over the depth $0.25$ μm < $x$ < 1 μm. Find the new sheet resistance.