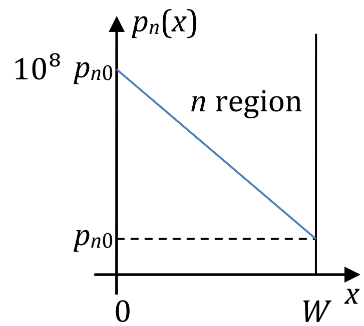
HW#3
(Submit to bCourses by 11 pm on 2/15)

1) For a p-type silicon in which the dopant concentration $N_A = 5 \times 10^{18}/\text{cm}^3$, find the hole and electron concentrations at $T = 300$ K.

2) Find the current that flows in a silicon bar of 10 μm length having a 5 μm × 4 μm cross-section and having free-electron and hole densities of $10^4/\text{cm}^3$ and $10^{16}/\text{cm}^3$, respectively, when a 1 V is applied end-to-end. Use $\mu_n = 1200\ \text{cm}^2/\text{V}\cdot\text{s}$ and $\mu_p = 500\text{cm}^2/\text{V}\cdot\text{s}$.

3) Holes are being steadily injected into a region of n-type silicon (connected to other devices, the details of which are not importation for this question). In the steady state, the excess-hole concentration profile show in the following figure is established in the n-type silicon region. Here "excess" means over and above the thermal-equilibrium concentration (in the absence of hole injection), denoted p_{n0}. If $N_D = 10^{16}/\text{cm}^3$, $n_i = 1.5 \times 10^{10}/\text{cm}^3$, $D_p = 12\ \text{cm}^2/\text{s}$, and $W = 50$ nm, find the density of the current that will flow in the x direction.



4) Calculate the built-in voltage of a junction in which the p and n regions are doped equally with $5 \times 10^{16}\text{atoms}/\text{cm}^3$. Assume $n_i = 1.5 \times 10^{10}/\text{cm}^3$. With the terminals left open, what is the width of the depletion region, and how far does it extend into the p and n regions? If the cross-sectional area of the junction is $20\ \mu\text{m}^2$, find the magnitude of the charge stored on either side of the junction.