1. a) $R = \frac{\rho L}{A}$

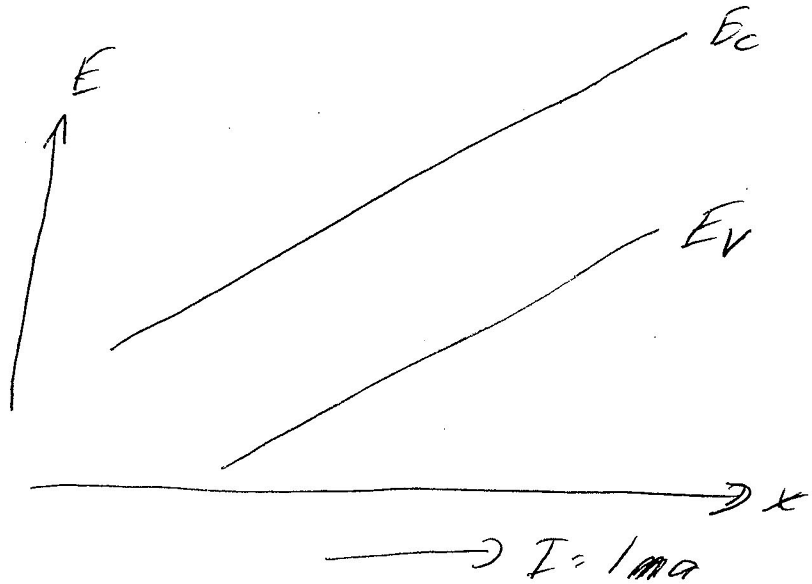
$$\rho = \frac{1}{\sigma} = \frac{1}{q\mu_n n + q\mu_p p}$$

$n = p = n_i = 1.1 \times 10^{10}\ cm^{-3}$

$\mu_n \approx 1358\ \frac{cm^2}{V\cdot s}$

$\mu_p \approx 461\ \frac{cm^2}{V\cdot s}$

$\rho = 3.1 \times 10^5\ \Omega\text{-}cm$



No Fermi Level is associated with this diagram because it is not in equilibrium. (There is an applied field) b.)

$G_L = 10^{18}\, cm^{-3} sec^{-1}$

$p = \Delta p + p_o \qquad n = \Delta n + n_o$

$\Delta p = \Delta n = G_L \tau_n = G_L \tau_p$

$= (10^{18})(10^{-6})$

$= 10^{12}\, cm^{-3}$

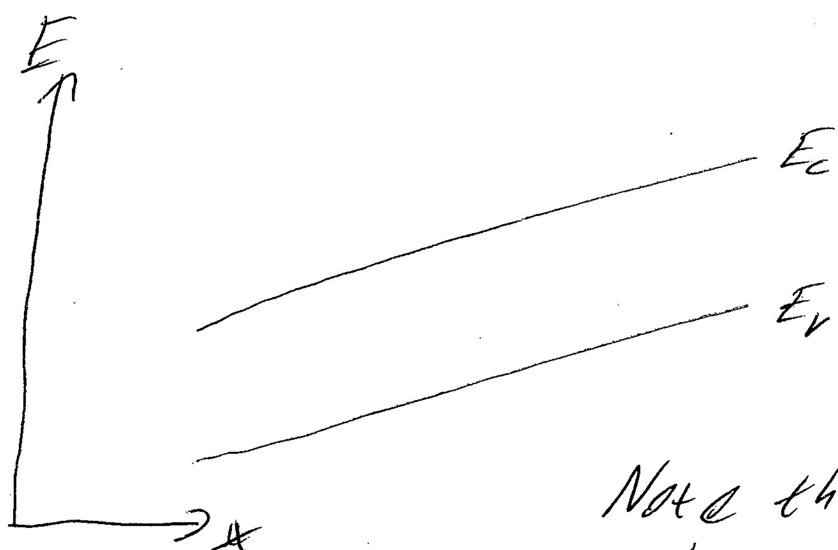
since $\Delta p = \Delta n >> n_i$

~~then~~ $p \sim n \sim 10^{12}\, cm^{-3}$

$\rho = \frac{1}{\sigma} = \frac{1}{q\mu_n n + q\mu_p p}$

<u>There are no additional scattering</u>
<u>centers, $\therefore$ μ_n & μ_p stay the same!</u>

$\rho = 3.4 \times 10^3\, \Omega\text{-cm}$



Note that the slope of E_c
is greatly reduced here
because the lower ρ means lower voltage.

c.) If N_T were reduced by a factor of 2 in the first half of the slab, then

$$-c_p N_T \Delta p = \left.\frac{\partial p}{\partial t}\right|_{R-G} \qquad -c_n N_T \Delta n = \left.\frac{\partial n}{\partial t}\right|_{R-G}$$

If N_T decreases then the recombination rate will be reduced. This means more carriers will exist in the 1st half of the sample where N_T has decreased.

$$\tau_p = \frac{1}{c_p N_T} \Rightarrow \frac{1}{c_p \frac{1}{2} N_T}$$

$$\Delta p = G_L \tau_p \Rightarrow G_L\, 2\times 10^{-6}$$

$$\Delta p = 2\times 10^{12}$$

& similarly $\Delta n = 2\times 10^{12}$

$\therefore$ ρ is cut in half in first part of sample!

(2) Highly n-type $\Rightarrow$ free hole currents are negligible

Total e^- current = drift + diffusion

$$J_n = qn\mu_n \mathcal{E} + qD_n \frac{dn}{dx}$$

$$0 = \cancel{q}n\mu_n \mathcal{E} + \cancel{q}D_n \frac{dn}{dx}$$

$$\mathcal{E} = -\frac{1}{n}\frac{dn}{dx}\frac{D_n}{\mu_n}$$

$$= -\frac{1}{n}\frac{dn}{dx}\frac{\frac{kT}{q}\cancel{\mu_n}}{\cancel{\mu_n}}$$

$$\mathcal{E} = -\frac{kT}{q}\frac{1}{n}\frac{dn}{dx}$$

if $\mathcal{E}$ is constant, then $\frac{1}{n}\frac{dn}{dx}$ must be constant with x as well

$$\Rightarrow \frac{dn}{dx} = (\text{const.})\, n$$

n must be exponential

$$\underline{n = n_0 e^{-ax}}$$

1.) If n is exponential then this implies that the doping concentration is exponential as well.

2.) In the presence of a nonuniform concentration, the electron distribution diffuses towards regions of lower concentration.

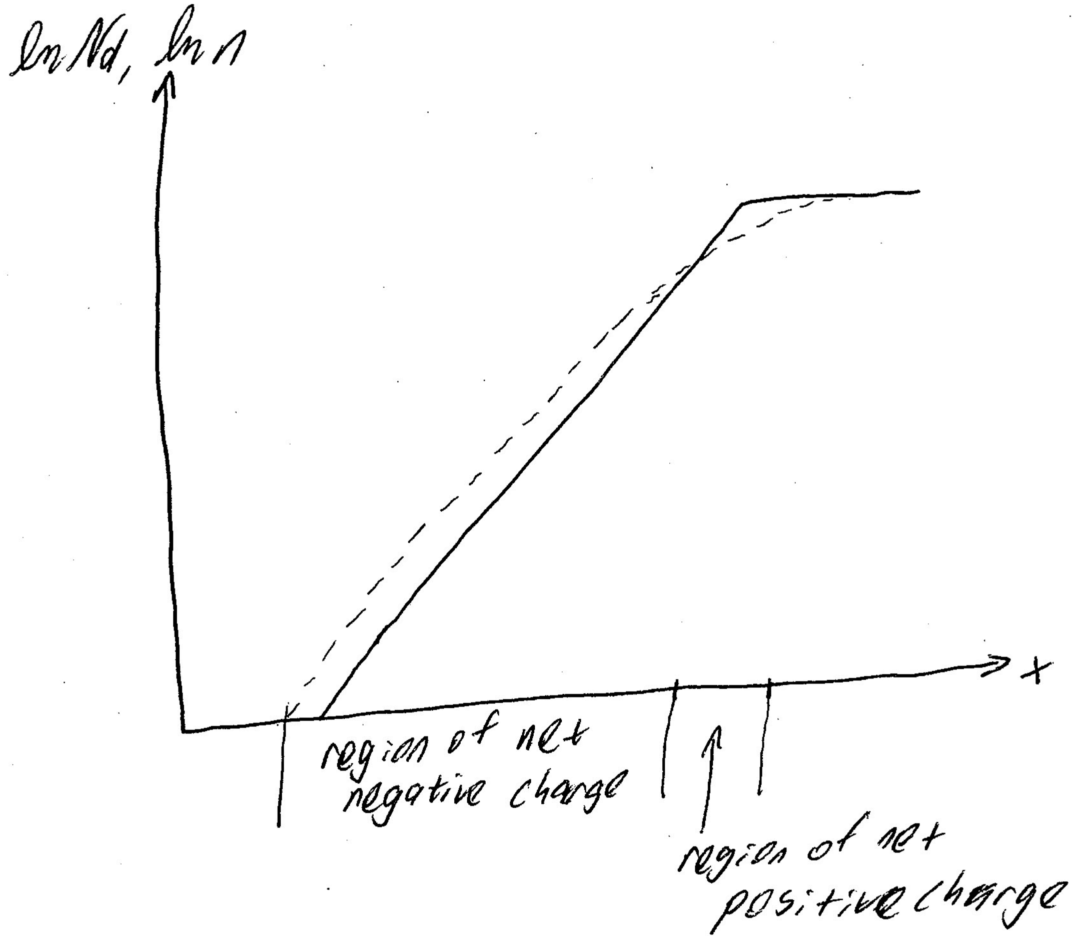
3.) Since the electron distribution has moved away from the dopant concentration, the negative charges have partially moved away from the positive charges, thus breaking local charge neutrality.

4.) In response to this an electric field develops trying to move the negative charges back. This results in a drift current.

5.) At equilibrium, the drift and diffusion currents cancel one another to leave $J_n = 0$

ln Nd(x) ———

ln n(x) - - - -



sum of charge = 0