Homework From Chapter 2

2.7

$V_n = -\mu_n E = (-710)(3000) = -2.13 \times 10^6$ cm/s

$V_p = \mu_p E = (260)(3000) = 7.8 \times 10^5$ cm/s

$J_n = -qn V_n = (-1.6 \times 10^{-19})(10^{17})(-2.13 \times 10^6) = 3.41 \times 10^4$ A/cm^2

$J_p = qpV_p = (1.6 \times 10^{-19})(10^3)(7.8 \times 10^5) = 1.25 \times 10^{-10}$ A/cm^2

2.23 (Read Sec. 2.6)

$$p = \frac{(N_A - N_D) \pm \sqrt{(N_A - N_D)^2 + 4n_i^2}}{2} = 9.03 \times 10^{14} \text{ /cm}^3$$

& $n = n_i^2 / p = 2.77 \times 10^{12}$ /cm^3

However, since $N_A - N_D = 9 \times 10^{14}$ /cm^3 $\gg$ $2n_i = 10^{14}$ /cm^3

So we can assume $p = N_A - N_D = 9 \times 10^{14}$ /cm^3

& $n = n_i^2 / p = 2.78 \times 10^{12}$ /cm^3

So both results are almost the same

2.31

$N_D = 5 \times 10^{16}$ /cm^3 & $N_A = 0$

$\therefore N_D \gg N_A \Rightarrow$ n-type material

At $T = 300K \Rightarrow n_i = 10^{10}$ /cm^3

$\therefore n = N_D = 5 \times 10^{16}$ /cm^3 & $p = n_i^2 / n = 2 \times 10^3$ /cm^3

To find the mobility, use fig. 2.8

$\Rightarrow \mu_n = 870 \text{ cm}^2/\text{V.s}$ & $\mu_p = 310 \text{ cm}^2/\text{V.s}$

Now the resistivity is calculated as follows $(n \gg p)$

$$\rho \simeq \frac{1}{q\mu_n n} = \frac{1}{(1.6\times10^{-19})(870)(5\times10^{16})} = 0.144 \ \Omega.\text{cm}$$

2.45

$$J = -qD_n\left(-\frac{dn}{dx}\right) = qV_T\mu_n\frac{dn}{dx}$$

$$= (1.6\times10^{-19})(0.026)(350)\left(\frac{-10^{18}}{100\times10^{-6}}\right) = -14.56 \text{ kA/cm}^2$$