Chapter 2 (extra)

2.9 $J = Q\,v = 0.5\,\frac{C}{cm^3} \times 10^7\,\frac{cm}{s} = 5\times10^6\,\frac{A}{cm^2} = 5\,\frac{MA}{cm^2}$

2.12 a) $E = \frac{V}{L} = \frac{5V}{10\,\mu m} = 0.5\times10^6\ V/m$

b) $V_{max} = E_{max}\,L = 10^5\ V/cm \times 10\,\mu m = 100\ V$

2.27 a) Boron is an acceptor $\Rightarrow$ The material is P-type

b) $N_A = 5\times10^{18}\ cm^{-3} \gg 2n_i$

$\therefore\ p = N_A = 5\times10^{18}\ cm^{-3}$

$n = \frac{n_i^2}{p} = \frac{10^{20}}{5\times10^{18}} = 20\ cm^{-3}$

c) $n_i^2 = BT^3 \exp\left(-\frac{E_G}{kT}\right) = 1.08\times10^{31} \times (200)^3 \times \exp\left(-\frac{1.12}{8.62\times10^{-5}\times200}\right)$

$\therefore\ n_i^2 = 5.28\times10^{9}\ cm^{-6} \Rightarrow n_i = 72.65\times10^{3}\ cm^{-3}$

$\therefore\ p = N_A = 5\times10^{18}\ cm^{-3}$, $n = \frac{n_i^2}{p} \approx 10^{-9}\ cm^{-3}$

2.33 Indium is from column 3 (like Boron), so it's an acceptor. So we've a p-type with $N_A = 7\times10^{19}\ cm^{-3} \gg 2n_i$ at 300K.

$\therefore\ p = N_A = 7\times10^{19}\ cm^{-3}$, $n = \frac{n_i^2}{p} = 1.43\ cm^{-3}$

$N_A + N_D = 7\times10^{19}\ cm^{-3}$, so using Fig. 2.8 $\Rightarrow \mu_n = 105\ cm^2/V.s$, $\mu_p = 80\ cm^2/V.s$

$\therefore\ \rho \approx \frac{1}{q\mu_p p} = \frac{1}{(1.602\times10^{-19})(80)(7\times10^{19})} = 1.11\ m\Omega.cm$