

Chapter 1

Exercise Solutions

EX1.1

$$n_i = BT^{3/2} \exp\left(\frac{-E_g}{2kT}\right)$$

Given: $n_i = (2.1 \times 10^{12})(300)^{3/2} \exp\left(\frac{-1.4}{2(9.6 \times 10^{-3})(300)}\right)$ or $n_i = 1.3 \times 10^{15} \text{ cm}^{-3}$

Given: $n_i = (0.66 \times 10^{12})(300)^{3/2} \exp\left(\frac{-0.66}{2(9.6 \times 10^{-3})(300)}\right)$ or $n_i = 2.40 \times 10^{15} \text{ cm}^{-3}$

EX1.2

(a) (i) $n_s = N_d = 2 \times 10^{14} \text{ cm}^{-3}$

$$n_s = \frac{n_i^2}{\mu_s} = \frac{(0.5 \times 10^{14})^2}{2 \times 10^{14}} = 1.125 \times 10^9 \text{ cm}^{-3}$$

(ii) $p_s = N_n = 10^{17} \text{ cm}^{-3}$

$$n_s = \frac{n_i^2}{\mu_s} = \frac{(0.5 \times 10^{14})^2}{10^{17}} = 2.25 \times 10^7 \text{ cm}^{-3}$$

(b) (i) $n_s = N_d = 2 \times 10^{14} \text{ cm}^{-3}$

$$n_s = \frac{n_i^2}{\mu_s} = \frac{(0.8 \times 10^{14})^2}{2 \times 10^{14}} = 1.62 \times 10^{14} \text{ cm}^{-3}$$

(ii) $p_s = N_n = 10^{17} \text{ cm}^{-3}$

$$n_s = \frac{n_i^2}{\mu_s} = \frac{(0.8 \times 10^{14})^2}{10^{17}} = 3.24 \times 10^{-3} \text{ cm}^{-3}$$

EX1.3

(a) For n-type:

$$\rho^2 = \frac{1}{e\mu_s N_s} = \frac{1}{(0.6 \times 10^{-3})(6800)(2 \times 10^{14})} = 0.046 \text{ ohm-cm}$$

$$(b) J = \frac{1}{\rho} \cdot E \Rightarrow E = \rho J = (0.046)(175) = 8.04 \text{ V/cm}$$

EX1.4

Diffusion current density due to holes:

$$J_p = -eD_p \frac{dp}{dx}$$

$$= -eD_p (10^{12}) \left(\frac{-1}{E_p}\right) \exp\left(\frac{-x}{E_p}\right)$$

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