

## Chapter 1

### Exercise Solutions

#### EX1.1

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

$$\text{GaAs: } n_i = (2.1 \times 10^{19})(300)^{3/2} \exp\left(\frac{-1.4}{2(86 \times 10^{-6})(300)}\right) \approx \underline{n_i = 1.8 \times 10^6 \text{ cm}^{-3}}$$

$$\text{Ge: } n_i = (1.66 \times 10^{15})(300)^{3/2} \exp\left(\frac{-0.66}{2(86 \times 10^{-6})(300)}\right) \approx \underline{n_i = 2.40 \times 10^{11} \text{ cm}^{-3}}$$

#### EX1.2

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

$$p_p = \frac{n_i^2}{n_p} = \frac{(1.5 \times 10^{10})^2}{2 \times 10^{14}} = 1.125 \times 10^5 \text{ cm}^{-3}$$

$$\text{(ii) } p_p = N_A = 10^{15} \text{ cm}^{-3}$$

$$n_p = \frac{n_i^2}{p_p} = \frac{(1.5 \times 10^{10})^2}{10^{15}} = 2.25 \times 10^5 \text{ cm}^{-3}$$

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

$$p_p = \frac{n_i^2}{n_p} = \frac{(1.8 \times 10^6)^2}{2 \times 10^{14}} = 1.62 \times 10^{-4} \text{ cm}^{-3}$$

$$\text{(ii) } p_p = N_A = 10^{15} \text{ cm}^{-3}$$

$$n_p = \frac{n_i^2}{p_p} = \frac{(1.8 \times 10^6)^2}{10^{15}} = 3.24 \times 10^{-3} \text{ cm}^{-3}$$

#### EX1.3

(a) For n-type,

$$\rho = \frac{1}{e\mu_n N_D} = \frac{1}{(1.6 \times 10^{-19})(6800)(2 \times 10^{15})} = 0.046 \text{ ohm-cm}$$

$$\text{(b) } J = \frac{1}{\rho} E \Rightarrow E = \rho J = (0.046)(1.75) = 3.04 \text{ V/cm}$$

#### EX1.4

Diffusion current density due to holes:

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

$$= -eD_p (10^{16}) \left( \frac{-1}{L_p} \right) \exp\left(\frac{-x}{L_p}\right)$$

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