Second Part

→ Now if we add Donor type impurities the material becomes n-Type.

→ Impurities are added to 1 Atom per 10^8 Si

$$\therefore N_D = \frac{5\times10^{22}}{10^8} = 5\times10^{14} \text{ atoms/cm}^3$$

→ So

$$\sigma = n\mu_n q$$
$$= N_D \cdot \mu_n q$$
$$= 5\times10^{14} \times 1300 \times 1.6\times10^{-19}$$
$$\sigma = 0.104 \,(\Omega\cdot cm)$$

→ Also $\boxed{\text{Resistivity} = 1/\sigma = 9.61 \,(\Omega\cdot cm).}$

4) A sample of Ge is doped to extent of 10^{14} Donor Atoms/cm^3 and 7×10^{13} acceptor atom/cm^3. At the temprature of sample the resistivity of pure Ge is 60 Ω.cm If the applied electric field is 2 V/cm. Find the current density. (use $J=\sigma E$).

Ans - Given,

$N_D = 10^{14}$ Atoms/cm^3

$N_A = 7\times10^{13}$ Atoms/cm^3.

$$\text{Resistivity} = 60 \,(\Omega\cdot cm) = 1/\sigma$$

→ Now

$$\sigma = \frac{1}{60} \; (\Omega \cdot cm)^{-1}$$

$$\therefore \; n_i(\mu_n + \mu_p)q = \frac{1}{60}$$

$$\therefore \; n_i = \frac{1}{60 \times 1.6\times10^{-19} \times (3800+1800)}$$

$$= 1.86 \times 10^{13} \text{ electron/cm}^3.$$

[Note

→ Now from Numerical - 1,

$$P = N_A + n - N_D \quad \text{——} \; (1)$$

And

$$n = -\frac{(N_A - N_D)}{2} + \sqrt{\frac{(N_A-N_D)^2}{4} + n_i^2} \quad \text{——} \; (2).$$

→ Here, I am going to use equation Directly but in exam you are required to find this equation as we have done in Numerical - 1]

→ By putting the values of N_D and N_A

$$n = 3.889 \times 10^{13} \text{ electrons/cm}^3$$

$$P = 0.889 \times 10^{13} \text{ Holes/cm}^3.$$

→ Now

$$J = \sigma \cdot E$$

$$= (n\mu_n + P\mu_p)q \cdot E.$$

$$= [(3.889\times10^{13} \times 3800) + (0.889\times10^{13}\times1800)] \times 1.6\times10^{-19} \times 2$$

$$= 0.0524 \text{ A/cm}^3$$

$$\boxed{J = 52.4 \text{ mA/cm}^3}$$

5) The intrinsic resistivity of Ge at 300 K is 0.47 Ω-m. Calculate the density of electrons in the intrinsic material. Also calculate the drift velocity of Holes and electrons for an electric field of 10^4 V/m. (Obtain your answer in CGS scheme)

Note - Underlined Value is changed from given Value.

Ans.) Resistivity of Intrinsic

Resistivity Ge $= 0.47\ \Omega \cdot m$

$= 0.47 \times 100\ (\Omega \cdot cm)$

$\therefore\ \sigma_i = \dfrac{1}{0.47 \times 100}\ (\Omega \cdot cm)^{-1}$

$\therefore\ n_i q(\mu_n + \mu_p) = \dfrac{1}{0.47 \times 100}$

$\therefore\ n_i = \dfrac{1}{0.47 \times 100 \times 1.6 \times 10^{-19} \times (3800 + 1800)}$

$$\boxed{\therefore n_i = 2.374 \times 10^{13}\ \text{electrons}/cm^3}$$

→ Now,

Drift velocity of Electron $= v_n = \mu_n E$

$= 3800 \times \dfrac{10^4}{100}\ cm/s$

$$\boxed{v_n = 3.8 \times 10^5\ cm/s}$$

Drift velocity of Holes $= v_p = \mu_p \cdot E$

$\therefore\ v_p = 1800 \times \dfrac{10^4}{100}\ cm/s$

$$\boxed{\therefore v_p = 1.8 \times 10^5\ cm/s}$$

6) Find the Diffusion constant D_p and D_n at Temprature 300 K. for Silicon and Germanium.

Ans:) We know that, $\frac{D_p}{\mu_p} = \frac{D_n}{\mu_n} = V_T$ —— (1)

And $V_T = \frac{T}{11,600}$

-> Now $T = 300$ K

$\therefore V_T = \frac{300}{11,600} = 0.026$ V.

-> Now from Eq 1

$D_p = V_T \cdot \mu_p$

$= 0.026 \times \cancel{1300}$ 500

$\boxed{\therefore D_p = 13 \ cm^2/s}$

-> Also

$D_n = V_T \cdot \mu_n$

$= 0.026 \times 1300$

$\boxed{\therefore D_n = 34 \ cm^2/s.}$

→ For Germanium.

$$V_T = \frac{T}{11,600} = 0.026 \text{ v.}$$

Given for
$\mu_e = 1800 \text{ cm}^2/\text{V.S}$
$\mu_n = 3800 \text{ cm}^2/\text{V.S}$.

→ Now From eq 1

$$D_p = V_T \cdot \mu_p.$$

$$= 0.026 \times 1800.$$

$$\boxed{D_p = 47 \text{ cm}^2/\text{s}}$$

→ From eq (1)

$$D_n = V_T \cdot \mu_n$$

$$= 0.026 \times 3800$$

$$\boxed{D_n = 99 \text{ cm}^2/\text{s.}}$$

X Best of Luck X