Quiz - 1 Answer Keys

Ans1. a) When T is very high $n_i(T)$ is large

and $n_i(T) >> N_A$

$\therefore$ E_F will be close to or same as E_i

b) When T is Room temperature,

$n_i(T) << N_A$

$\therefore$ E_F will be close to valence band edge

Sol.2) Given $N_D = 5 \times 10^{17} / cm^3$

a) Type of majority charge carrier — electron

Concentration, $n_0 \approx N_D = 5 \times 10^{17} / cm^3$

b) $E_F - E_i = KT \ln\left(\frac{N_D}{n_i}\right)$

$= 0.026 \ln\left(\frac{5 \times 10^{17}}{1.5 \times 10^{10}}\right)$

$\Rightarrow$ $\boxed{E_F - E_i = 0.4501 eV}$

c) Concentration of minority charge carrier,

$$P_0 = \frac{n_i^2}{N_D} = \frac{(1.5\times10^{10})^2}{5\times10^{17}}$$

$$\Rightarrow \boxed{P_0 = 4.5\times10^{2}\ /cm^3}$$

d) $$E_i - E_f = KT \ln\left(\frac{P_0}{n_i}\right)$$

$$= 0.026 \times \ln\left(\frac{4.5\times10^{2}}{1.5\times10^{10}}\right)$$

$$\boxed{E_i - E_f = -0.4503eV}$$

Ans. 3 $$N_A^- + n_0 = N_D^+ + P_0$$

Considering $N_A > N_D$, semiconductor is P-type

$$P_0 = \left(N_A^- - N_D^+\right) + n_0$$

$$\Rightarrow P_0 = \left(N_A^- - N_D^+\right) + \frac{n_i^2}{P_0}$$

$$\Rightarrow P_0^2 - \left(N_A^- - N_D^+\right)P_0 - n_i^2 = 0$$

$$P_0 = \left(N_A^- - N_D^+\right) + \sqrt{\left(N_A^- - N_D^+\right)^2 + 4n_i^2}$$

$p_0 = \dfrac{(\quad H \quad D) - \sqrt{\quad H \quad D}}{2}$

$$\Rightarrow \boxed{P_0 = \frac{N_A^- - N_D^+}{2} + \sqrt{\left(\frac{N_A^- - N_D^+}{2}\right)^2 + n_i^2}}$$

The root with $\dfrac{-b - \sqrt{b^2-4ac}}{2}$, has been discarded as this would have resulted into -ve P_0 value which is not possible.

Sol. 4) $N_A = 10^{16}/cm^3$

$N_A^+ = 70\%$ of $10^{16}/cm^3$

$= 7 \times 10^{15}/cm^3$

$\sigma \approx q \mu_p P$

$\Rightarrow \sigma = 1.6 \times 10^{-19} \times 350 \times 7 \times 10^{15}$

$$\boxed{\sigma = 0.392 \text{ S/cm}}$$

Ans. 5) → Type of majority carrier

→ Concentration of majority carrier

→ mobility of majority carrier

→ resistivity / conductivity