Intrinsic Semiconductor

n: No of electrons
p: No. of ~~protons~~ holes

At $T = 0K$

No Charge Carriers are there

$$\boxed{n = p = 0}$$

At $T > 0K$

Electron-hole pair are generated

$$\boxed{n = p = n_i}$$

Where $n_i \Rightarrow$ Intrinsic Carrier Concentration

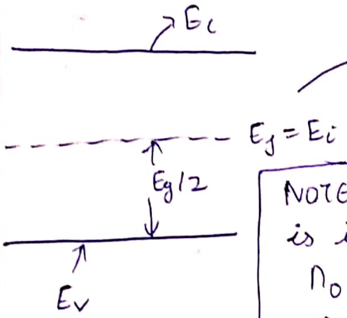
& At equillibrium Concentration

$$g_i = r_i = \alpha_r n_o p_o = \alpha_r n_i^2$$

$g_i \Rightarrow$ Rate of generation of electron-hole
$r_i \Rightarrow$ Rate of Combination of "

$n_o \Rightarrow$ No of electrons at equillibrium Concentration

$p_o \Rightarrow$ No. of holes at equillibrium Concentration



For Intrinsic Semiconductor

NOTE: If a semiconductor is intrinsic then $n_o = p_o = n_i$ for any given Temperature 'T'

At any Temperature 'T'

$$N_o = n_i \, e^{\frac{(E_f - E_i)}{KT}}$$

$$P_o = n_i \, e^{\frac{(E_i - E_f)}{KT}}$$

$E_f \rightarrow$ Fermi Energy
$E_i \rightarrow \frac{E_g}{2}$
$\hookrightarrow$ Energy of intrinsic level

Where N_o & P_o are no of electrons & holes at That Temperature

For Pure Intrinsic Semiconductor

$E_f = E_i \Rightarrow$ So, $N_o = n_i$ & $P_o = n_i$

N_A : No of acceptor atoms (Group-13)
N_d : No of donor atoms (Group-15)

Extrinsic Semiconductor

If $N_d > N_A$ or $N_A = 0$

$\Downarrow$

$\boxed{n \text{ type Semiconductor}}$

$$n_o = (N_D - N_A)$$

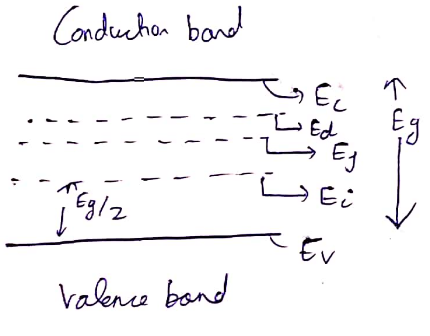
To find p_o use $\boxed{n_o p_o = n_i^2}$

Here At any Temperature 'T'
$n_o \neq p_o \neq n_i$
$n_o >> p_o$

If N_D & N_A is not given then

$$n_o = N_c \, e^{-\frac{(E_c - E_F)}{KT}} \Rightarrow N_c = 2 \times \left(\frac{2\pi m_n^* kT}{h^2}\right)^{3/2}$$

$$p_o = N_V \, e^{-\frac{(E_f - E_v)}{KT}} \quad N_V = 2\left(\frac{2\pi m_p^* kT}{h^2}\right)^{3/2}$$



Also,

$$n_o = n_i e^{\left(\frac{E_f - E_i}{KT}\right)}$$

$$p_o = n_i e^{\left(\frac{E_i - E_f}{KT}\right)}$$

Where $E_i = \frac{E_g}{2}$

If $N_A > N_D$ or $N_D = 0$

$\Downarrow$

$\boxed{p\text{-type Semiconductor}}$

$$\boxed{p_o = N_A - N_D}$$

To find n_o use $n_o p_o = n_i^2$

Here at Any Temperature 'T'
$n_o \neq p_o \neq n_i$
$p_o >> n_o$

If N_D & N_A is not given

$$n_o = N_c \, e^{-\left(\frac{E_c - E_f}{KT}\right)}$$

$$p_o = N_v \, e^{-\left(\frac{E_f - E_v}{KT}\right)}$$

Also,

$$n_o = n_i e^{\left(\frac{E_f - E_i}{KT}\right)}$$

$$p_o = n_i e^{\left(\frac{E_i - E_f}{KT}\right)}$$