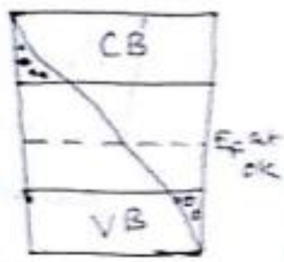
$$\boxed{E_F = \frac{E_c + E_v}{2} + \frac{3}{4} k_B T \log\left(\frac{m_h^*}{m_e^*}\right)} \quad — (13)$$

If $m_h^* = m_e^*$, then $\log \frac{m_h^*}{m_e^*} = 0$ $\quad [\because \log 1 = 0]$

$$E_F = \frac{E_c + E_v}{2} \quad — (14)$$

i.e., Fermilevel lies in the midway between E_c and E_v (at $T = 0K$). But Fermilevel slightly increases with increase in temperature.

CB - conduction band
VB - valence band



Density of electrons and holes interms of E_g :-

Interms of Energy gap $(E_g = E_c - E_v)$, we can get the expression of n_e and n_h by substituting the value of E_F interms of E_c and E_v.

We know,

$$n_e = 2\left(\frac{2\pi m_e^* k_B T}{h^2}\right)^{3/2} e^{(E_F - E_c)/k_B T}$$

$$n_e = 2\left(\frac{2\pi m_e^* k_B T}{h^2}\right)^{3/2} \cdot \exp\left[\frac{\frac{E_c + E_v}{2} + \frac{3}{4} k_B T \log\left(\frac{m_h^*}{m_e^*}\right) - E_c}{k_B T}\right]$$

$$= 2\left(\frac{2\pi m_e^* k_B T}{h^2}\right)^{3/2} \exp\left[\frac{2E_c + 2E_v + 3 k_B T \log\left(\frac{m_h^*}{m_e^*}\right) - 4E_c}{4 k_B T}\right]$$

$$= 2\left(\frac{2\pi m_e^* k_B T}{h^2}\right)^{3/2} \exp\left[\frac{-2E_c + 2E_v + 3k_BT\log_e\left(\frac{m_h^*}{m_e^*}\right)}{4k_BT}\right]$$

$$= 2\left(\frac{2\pi m_e^* k_B T}{h^2}\right)^{3/2} \exp\left[\frac{2(E_v - E_c)}{4k_BT} + \frac{3}{4}\log_e\left(\frac{m_h^*}{m_e^*}\right)\right]$$

we know, $E_g = E_c - E_v$

$$n_e = 2\left(\frac{2\pi m_e^* k_B T}{h^2}\right)^{3/2} \exp\left[\frac{-E_g}{2k_BT} + \log_e\left(\frac{m_h^*}{m_e^*}\right)^{3/4}\right]$$

$$n_e = 2\left(\frac{2\pi k_B T}{h^2}\right)^{3/2} \cdot e^{-E_g/2k_BT} \cdot (m_e^*)^{3/2} \cdot \frac{(m_h^*)^{3/4}}{(m_e^*)^{3/4}}$$

$$n_e = 2\left(\frac{2\pi k_B T}{h^2}\right)^{3/2} e^{-E_g/2k_BT} \cdot (m_e^*)^{3/4} \cdot (m_h^*)^{3/4}$$

$\frac{3}{2} - \frac{3}{4} = \frac{6-3}{4} = \frac{3}{4}$

$$\boxed{n_e = 2\left(\frac{2\pi k_B T}{h^2}\right)^{3/2} \cdot e^{-E_g/2k_BT} \cdot (m_e^* \cdot m_h^*)^{3/4}} \quad \text{— (15)}$$

lly $$n_h = 2\left(\frac{2\pi k_B T}{h^2}\right)^{3/2} e^{-E_g/2k_BT} (m_h^* \cdot m_e^*)^{3/4} \quad \text{— (16)}$$

It is found that $n_e = n_h = n_i$. In an intrinsic semiconductor density of electrons in conduction band is equal to the density of holes in valence band.

$n_i = n_e = n_h$

$$\boxed{n_i = 2\left(\frac{2\pi k_B T}{h^2}\right)^{3/2} (m_e^* \cdot m_h^*)^{3/2} e^{-E_g/2k_BT}} \quad \text{— (17)}$$

equation (17) is the carrier concentration for intrinsic semiconductor.