

PN Junction (1A)

- Drift Current
- Diffusion Current

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Electron & Hole Concentration

$$n_0 = \int_{E_c}^{\infty} f(E) N(E) dE$$

$$n_0 \approx \int_{E_c}^{\infty} f(E_c) N(E) dE$$

$$= f(E_c) \int_{E_c}^{\infty} N(E) dE$$

$$= f(E_c) \cdot N_c$$

$$f(E_c) = \frac{1}{1 + e^{(E_c - E_F)/kT}}$$

$$\approx e^{(E_F - E_c)/kT}$$

$$n_0 = N_c e^{(E_F - E_c)/kT}$$

$$p_0 = \int_{-\infty}^{E_v} (1 - f(E)) N(E) dE$$

$$p_0 \approx \int_{-\infty}^{E_v} (1 - f(E_v)) N(E) dE$$

$$= (1 - f(E_v)) \int_{-\infty}^{E_v} N(E) dE$$

$$= (1 - f(E_v)) \cdot N_v$$

$$1 - f(E_v) = 1 - \frac{1}{1 + e^{(E_v - E_F)/kT}}$$

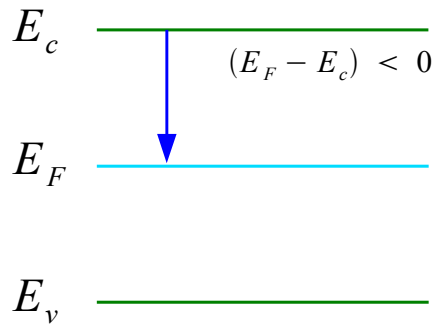
$$\approx e^{(E_v - E_F)/kT}$$

$$p_0 = N_v e^{(E_v - E_F)/kT}$$

Electron & Hole Concentration

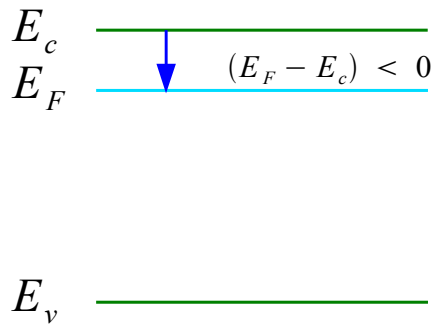
$$n_0 = N_c e^{(E_F - E_c)/kT}$$

n_1 intrinsic

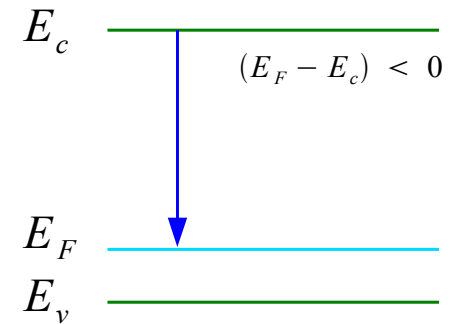


$$n_2 > n_1 > n_3$$

n_2 n-type

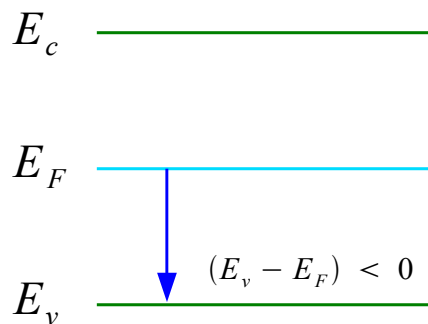


n_3 p-type



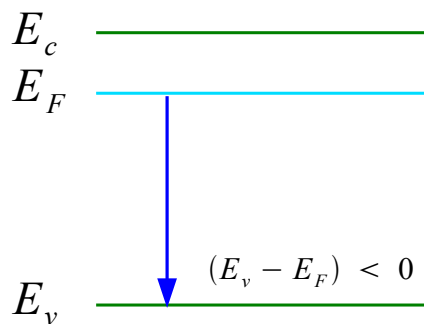
$$p_0 = N_v e^{(E_v - E_F)/kT}$$

p_1 intrinsic

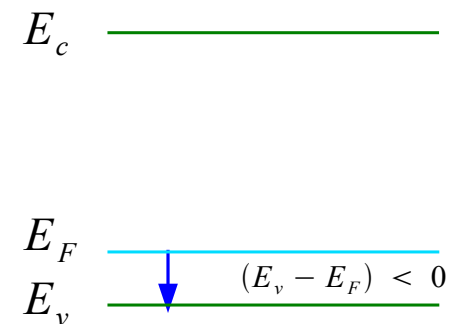


$$p_3 > p_1 > p_2$$

p_2 n-type

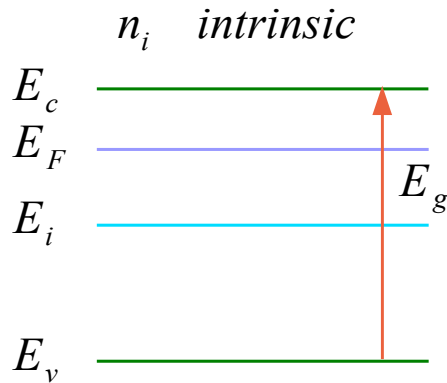


p_3 p-type



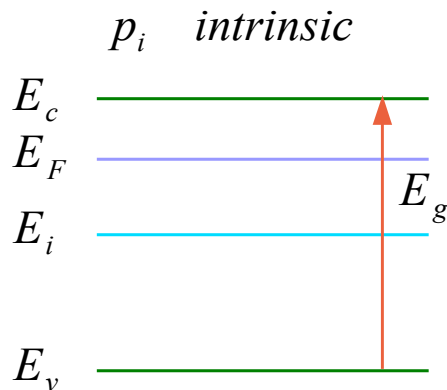
Electron & Hole Concentration

$$n_i = N_c e^{(E_i - E_c)/kT}$$



$$\begin{aligned} n_i p_i &= N_c e^{(E_i - E_c)/kT} N_v e^{(E_v - E_i)/kT} \\ &= N_c N_v e^{(E_v - E_c)/kT} \\ &= N_c N_v e^{-E_g/kT} \end{aligned}$$

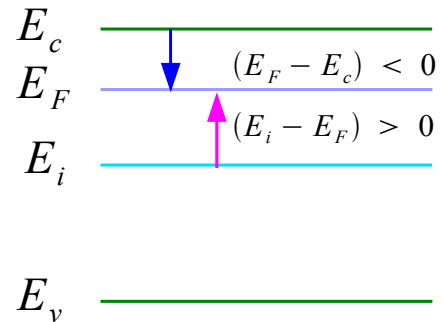
$$\begin{aligned} n_0 p_0 &= N_c e^{(E_F - E_c)/kT} N_v e^{(E_v - E_F)/kT} \\ &= N_c N_v e^{(E_v - E_c)/kT} \\ &= N_c N_v e^{-E_g/kT} \end{aligned}$$



$$n_0 p_0 = n_i p_i = n_i^2$$

Electron & Hole Concentration

$$n_0 = N_c e^{(E_F - E_c)/kT}$$

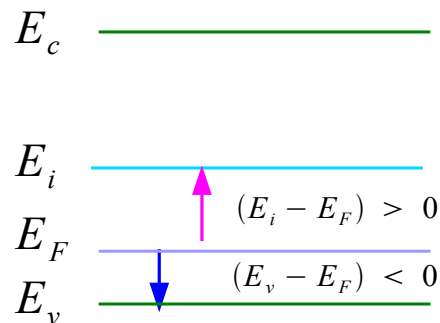


$$n_0 = N_c e^{(E_F - E_c)/kT}$$

$$= N_c e^{(E_i - E_c)/kT} e^{(E_F - E_i)/kT}$$

$$= n_i \cdot e^{(E_F - E_i)/kT}$$

$$p_0 = N_v e^{(E_v - E_F)/kT}$$



$$p_0 = N_v e^{(E_v - E_F)/kT}$$

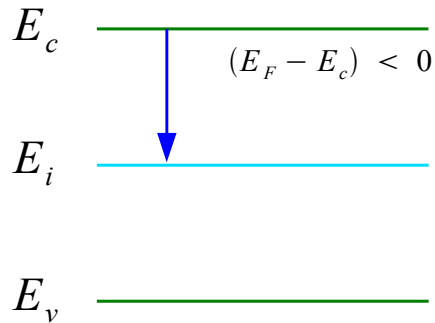
$$= N_v e^{(E_v - E_i)/kT} e^{(E_i - E_F)/kT}$$

$$= p_i \cdot e^{(E_i - E_F)/kT}$$

Electron & Hole Concentration

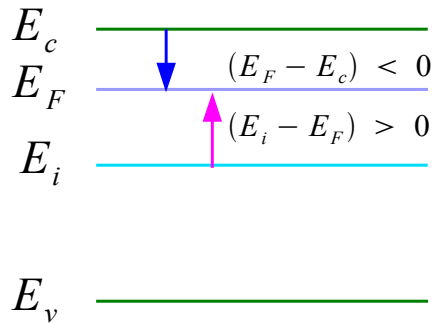
$$n_0 = N_c e^{(E_F - E_c)/kT}$$

n_1 intrinsic

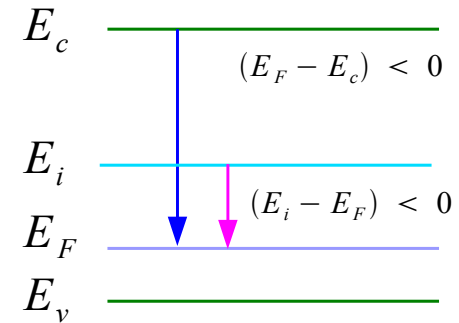


$$n_2 > n_1 > n_3$$

n_2 n-type

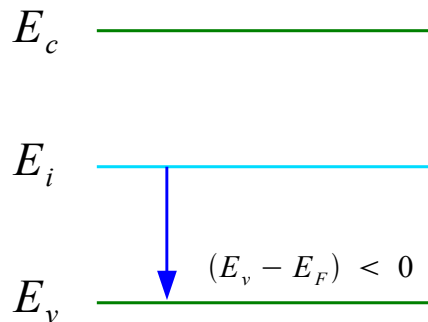


n_3 p-type



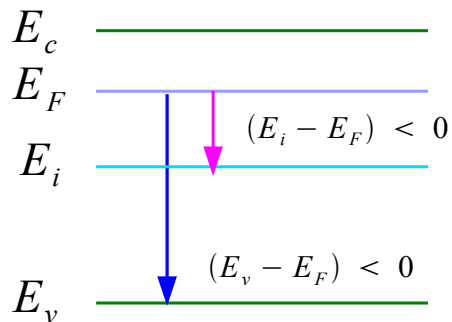
$$p_0 = N_v e^{(E_v - E_F)/kT}$$

p_1 intrinsic

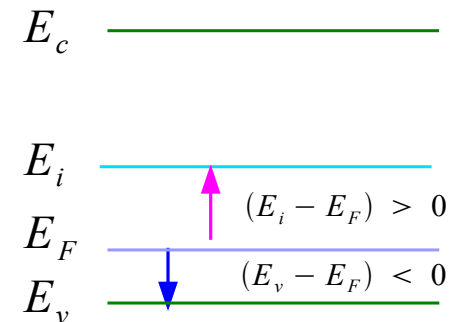


$$p_3 > p_1 > p_2$$

p_2 n-type



p_3 p-type



Electron & Hole Concentration

$$n = N_c e^{\left(\frac{E_f - E_c}{kT}\right)}$$

$$E_c < E_f < E_v$$

$$f(E) \approx e^{\left(\frac{E - E_f}{kT}\right)}$$

$$n = N_c e^{\left(\frac{E_f - E_c}{kT}\right)}$$

$$p = N_v e^{\left(\frac{E_f - E_c}{kT}\right)}$$

$$E_c < E_f < E_v$$

$$1 - f(E) \approx e^{\left(\frac{E - E_f}{kT}\right)}$$

$$p = N_v e^{\left(\frac{E_f - E_c}{kT}\right)}$$

Electron & Hole Concentration

$$n = p$$

$$N_c e^{\left(\frac{E_f - E_c}{kT}\right)} = N_v e^{\left(\frac{E_f - E_c}{kT}\right)}$$

$$E_{fo} = \frac{1}{2}(E_c + E_v) + \frac{3}{4}kT \log \frac{m_v}{m^*}$$

$$n^2 = p^2 = n_i^2$$

$$n = p = n_i = (N_c N_v)^{1/2} e^{\left(\frac{-E_g}{2kT}\right)}$$

References

[1] <http://en.wikipedia.org/>