(l) Einstein Relationship

Since both diffusion and mobility are statistical thermodynamic phenomena, D and μ are not independent. The relationship between them is given by

$\frac{D_p}{\mu_p} = \frac{D_n}{\mu_n} = V_T$ where V_T is the 'Volt-equivalent of temperature'.

$$V_T = \frac{kT}{q} = \frac{T}{11,600} V$$

$k \rightarrow$ Boltzmann constant in electron volts per degree Kelvin

At room temperature $T = 300^0\ K$, $V_T = 0.026\ V \Rightarrow \mu = 39D$

Total Current in a Semiconductor

It is possible for both a potential gradient and a concentration gradient to exist simultaneously within a semiconductor. In such a situation, the total hole current is the sum of the drift current and the diffusion current, $J_p = q\mu_p pE - qD_p \frac{dp}{dx}$

Similarly the net electron current is: $J_n = q\mu_n nE + qD_n \frac{dn}{dx}$