Cheat Sheet

Constants

$N_A = 6.02 \times 10^{23}$ molecules/mole
$k = 1.38 \times 10^{-23}$ J/K
$= 8.62 \times 10^{-5}$ ev/K
$q = 1.60 \times 10^{-19}$ C
$m_0 = 9.11 \times 10^{-31}$ kg
$\epsilon_0 = 8.85 \times 10^{-14}$ F/cm
$h = 6.63 \times 10^{-34}$ Js
$= 4.14 \times 10^{-15}$ eVs
$kT = 0.0259$ eV
$c = 2.998 \times 10^{10}$ cm/s
$\mathring{\text{A}} = 10^{-8}$ cm
$1 \text{ eV} = 1.6 \times 10^{-19}$ J

Formulas

$p = mv = \hbar\vec{k} = \frac{h}{\lambda}$
$E = hv = \hbar\omega$
$E = \frac{1}{2}mv^2 = \frac{1}{2}\frac{p^2}{m} = \frac{\hbar}{2m^*}\vec{k}^2$
$m^* = \frac{\hbar^2}{\frac{d^2E}{dk^2}}$
$E_N = KE + PE = E_c + E(k) = -\frac{mq^4}{K^2n^2\hbar^2}$

	Classical Mechanics	Quantum Mechanics
Position	x	x
Momentum	$p = mv$	$\frac{\hbar}{j}\frac{\partial}{\partial x}$
Energy	$E = KE + PE = \frac{1}{2}mv^2 + PE$	$-\frac{\hbar}{j}\frac{\partial}{\partial t}$

$\langle Q \rangle = \int_{-\infty}^{\infty} \psi^* Q_{op} \psi \, d\vec{x}$
$Eg(x) = \int_{-\infty}^{\infty} g(x)P(x)dx$

n :extra electrons
p :extra holes

$f(E) = \frac{1}{e^{(E-E_F)/kT}+1} \approx e^{(E_F-E)/kT}$
$n_0 = N_c f(E_C)$

$N_c = 2(\frac{2\pi m_n^* kT}{h^2})^{3/2}$
$N_v = 2(\frac{2\pi m_p^* kT}{h^2})^{3/2}$
$p_0 = N_v f(E_v)$
$n_i = N_c e^{-(E_C - E_i)/kT} = \sqrt{N_c N_v} e^{-E_g/2kT}$
$p_i = N_v e^{-(E_i - E_C)/kT}$
$E = \frac{mq^4}{2K^2\hbar^2}$

Equilibrium

$n_0 = n_i e^{(E_F - E_i)/kT}$
$p_0 = n_i e^{(E_i - E_F)/kT}$
$n_0 p_0 = n_i^2$

Steady State

$n = N_c e^{-(E_C - F_n)/kT} = n_i e^{(F_n - E_i)/kT}$
$p = N_v e^{-(F_p - E_v)/kT} = n_i e^{(E_i - F_p)/kT}$
$np = n_i^2 e^{(F_n - F_p)/kT}$

Potential Well

$\psi = A \sin Kx$
$K = \frac{\sqrt{2mE}}{\hbar}$

$\psi_H = \sqrt{\frac{2}{L}} \sin \frac{nm}{L} x$
$\psi_K(X) = U(k_x, x) e^{jKxX}$