Comprehensives – Key Equations

$\nabla \cdot \underline{E} = \rho/\varepsilon$ $\quad$ $\underline{D} \equiv \varepsilon \underline{E} \, (+\underline{P})$ $\Rightarrow$ $\nabla \cdot \underline{D} = \rho$ $\quad$ $\underline{J} = \sigma \underline{E}$

$\nabla \cdot \underline{B} = 0$ $\quad$ $\underline{H} \equiv \frac{\underline{B}}{\mu} (-\underline{M})$ $\quad$ $\nabla \cdot \underline{H} = 0$

$\nabla \times \underline{E} = -\partial_t \underline{B}$ $\quad$ $\nabla \times \underline{D} = -\frac{\varepsilon}{\mu} \partial_t \underline{H}$

$\nabla \times \underline{B} = \mu \underline{J} + \mu \varepsilon \partial_t \underline{E}$ $\quad$ $\nabla \times \underline{H} = \underline{J} + \partial_t \underline{D}$

$f_{FD} = \left(e^{\frac{E-\mu}{k_B T}} + 1\right)^{-1}$

$f_{BE} = \left(e^{\frac{E-\mu}{k_B T}} - 1\right)^{-1}$

$E_0 = E_F + \phi$

$j = n e \underline{v}$

$\underline{L} = \underline{r} \times \underline{p} = I \underline{\omega}$

$\underline{\Gamma} = \underline{r} \times \underline{F} = I \dot{\underline{\omega}}$

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adiabat $\Rightarrow$ $PV^{\gamma} = TV^{\gamma-1} = \text{const.}$

$\gamma = \frac{n_d + 2}{n_d}$, $\quad U = \frac{n_d}{2} N k_B T$

$S = k_B \ln \Omega$, $\quad p_j = \frac{e^{-\frac{E_j}{k_B T}}}{Z}$

$\Omega = \frac{N! \prod_j g_j^{n_j}}{\prod_j n_j!}$, $\quad Z = \sum_j g_j e^{-E_j/k_B T}$

$dU = dQ - dV$

$dS \geq 0$

$dU = T dS - P dV$

Faraday's law, $\varepsilon = -\frac{\partial \Phi}{\partial t}$

Ampère's law, $\oint \underline{B} \cdot \underline{dl} = \mu I$

perturbation, $\Delta E = \langle \psi_0 | \hat{H}_1 | \psi_0 \rangle$

with $\hat{H} = \hat{H}_0 + \hat{H}_1$

$\underline{N} = \underline{E} \times \underline{H}$ $\quad$ $r^2 \sin\theta \, d\theta$

$\langle P \rangle = \oiint_S \langle \underline{N} \rangle \cdot \underline{ds}$

$v_\phi = \omega/k$

$v_g = \frac{\partial \omega}{\partial k}$

Lorentz, $\underline{F} = q(\underline{E} + \underline{v} \times \underline{B})$

with $\underline{E} = -\nabla V$

Hermitian, $\int \psi^* \hat{H} \psi \, dx = \int (\hat{H}\psi)^* \psi \, dx$

$\hat{p} = -i\hbar \partial_x$

$\tan \theta_B = \frac{n_2}{n_1}$ (all energy transmitted)

$n_1 \sin \theta_c = n_2$ (no TIR)

$n_1 \sin \theta_1 = n_2 \sin \theta_2$

$N = \int_0^{E_F} D(E) dE$

$D(E) \equiv \frac{dN}{dE}$

$\langle E \rangle = \int_0^{E_F} D(E) E \, dE$

$P(n) = \frac{e^{-\mu} \mu^n}{n!}$ (Poisson)

$P(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$ (Gauss)

$P(x) = {}^N C_x \, p^x q^{N-x}$ (Binomial)

$\frac{N!}{x!(N-x)!}$