Physics 210 Equations

Electric Forces

$\vec{F} = k\frac{q_1 q_2}{r^2}\hat{r}$ $\vec{E} = \frac{\vec{F}}{q_0}$ $\vec{E} = k\frac{q}{r^2}\hat{r}$

$\vec{E} = k\sum_i \frac{q_i}{r_i^2}\hat{r}$ $\vec{E} = k\int\frac{dq}{r^2}\hat{r}$ $\vec{\tau} = \vec{p}\times\vec{E}$ $\vec{p} = 2\vec{a}q$ $P.E. = -\vec{p}\bullet\vec{E}$

Gauss's Law

$\oint\vec{E}\cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$ $\phi_E = \int\vec{E}\cdot d\vec{A}$

Electric Potential

$\Delta V = \frac{\Delta PE}{q_0} = -\int_A^B \vec{E}\bullet d\vec{s}$ $V = k\frac{q}{r}$ $V = k\int\frac{dq}{r}$ $P.E._{12} = k\frac{q_1 q_2}{r_{12}}$ $\vec{E} = -\vec{\nabla}V$

Capacitance and Dielectrics

$C = \frac{Q}{V}$ $C_{par} = \sum_i C_i$ $C_{ser} = \left(\sum_i \frac{1}{C_i}\right)^{-1}$

$P.E. = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{Q^2}{2C}$ $C = \kappa C_0$ $C = \frac{\varepsilon_0 A}{d}$

Current and Resistance

$I = \frac{dQ}{dt}$ $I = nqv_d A$ $J = \frac{I}{A} = nqv_d$ $\vec{J} = \sigma\vec{E}$

$V = IR$ $P = IV = I^2R = \frac{V^2}{R}$ $R = \rho\frac{L}{A}$ $\rho = \rho_0\left[1+\alpha\Delta T\right]$ $R = R_0\left[1+\alpha\Delta T\right]$

Magnetic Fields

$\vec{F} = q\vec{v}\times\vec{B}$ $\vec{\mu} = I\vec{A}$ $\vec{\tau} = N\vec{\mu}\times\vec{B}$ $F = \frac{mv^2}{r}$ $r = \frac{mv}{qB}$

$\omega = \frac{qB}{m}$ $\vec{F} = I\vec{L}X\vec{B}$ $P.E. = -\vec{\mu}\bullet\vec{B}$

Sources of the Magnetic Field

$\vec{B} = \frac{\mu_o I}{4\pi}\int\frac{d\vec{s}\times\hat{r}}{r^2}$ $\frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi a}$ $\oint\vec{B}\cdot d\vec{s} = \mu_0 I_{in}$

$B_{tor} = \frac{\mu_0 NI}{2\pi a}$ $B_{sol} = \mu_0\frac{N}{L}I$ $B_{\infty wire} = \frac{\mu_0 I}{2\pi r}$ $B_{loop} = \frac{\mu_0 I}{2r}$

$\Phi_m = \int\vec{B}\cdot d\vec{A}$ $\oint\vec{B}\cdot d\vec{s} = \mu_0\left(I + I_d\right)$ $I_d = \varepsilon_0\frac{d\Phi_E}{dt}$

Faraday's Law

$\varepsilon = -N\frac{d\Phi_m}{dt}$ $\Phi_m = \int\vec{B}\cdot d\vec{A}$ $\varepsilon = BLv$

Constants

$$\varepsilon_0 = 8.85\times10^{-12}\left[\frac{\mathrm{C}^2}{\mathrm{Nm}^2}\right]$$

$$\mu_0 = 4\pi\times10^{-7}\left[\frac{\mathrm{Tm}}{\mathrm{A}}\right]$$

$$g = 9.8\left[\frac{\mathrm{m}}{\mathrm{s}^2}\right]$$

$$m_p = 1.67\times10^{-27}\,[\mathrm{kg}]$$

$$m_e = 9.11\times10^{-31}\,[kg]$$

$$1\ eV = 1.6\times10^{-19}\,[\mathrm{J}]$$

$$q_e = -1.6\times10^{-19}\,[\mathrm{C}]$$

$$k = 9\times10^{9}\left[\frac{\mathrm{Nm}^2}{\mathrm{C}^2}\right]$$

$$c = 3\times10^{8}\left[\frac{\mathrm{m}}{\mathrm{s}}\right]$$