Useful Relationships

$$\vec{E}_{\text{spherical}} = \frac{Q}{4\pi\epsilon_0 r^2}\hat{r}$$

$$\vec{E}_{\text{line}} = \frac{\lambda}{2\pi\epsilon_0 r}\hat{r}$$

$$\vec{E}_{\text{plane}} = \frac{\sigma}{2\epsilon_0}\hat{k}$$

$$\Phi_E = \int \vec{E}\cdot d\vec{A}$$

$$\oint \vec{E}\cdot d\vec{A} = \frac{Q_{\text{encl.}}}{\epsilon_0}$$

$$V = \frac{Q}{4\pi\epsilon_0 r}$$

$$V = -\int \vec{E}\cdot d\vec{s}$$

$$\vec{F}_E = q\vec{E}$$

$$U_E = qV$$

$$dU = Vdq$$

$$CV = Q$$

$$C = \kappa\epsilon_0\frac{A}{d}$$

$$U = \tfrac{1}{2}QV$$

$$V = IR$$

$$I = \tfrac{dQ}{dt}$$

$$\mathcal{P} = IV$$

$$V(t) = V_0\left(1 - e^{-t/\tau}\right)$$

$$V(t) = V_0 e^{-t/\tau}$$

$$\tau = RC,\ \tau = R/L$$

$$\vec{F} = q(\vec{E} + \vec{v}\times\vec{B})$$

$$\omega_c = \tfrac{q}{m}B$$

$$r_c = \tfrac{mv}{qB}$$

$$d\vec{F} = Id\vec{\ell}\times\vec{B}$$

$$\vec{\mu} = I\vec{A}$$

$$\vec{\tau} = \vec{\mu}\times\vec{B}$$

$$\vec{B}_{\text{wire}} = \tfrac{\mu_0 I}{2\pi r}\hat{\theta}$$

$$\vec{B}_{\text{solenoid}} = \mu_0 nI\hat{z}$$

$$d\vec{B} = \tfrac{\mu_0 I d\vec{\ell}\times\hat{r}}{4\pi r^2}$$

$$\oint \vec{B}\cdot d\vec{s} = \mu_0 I_{\text{enci.}} + \mu_0\epsilon_0\tfrac{d\Phi_E}{dt}$$

$$\Phi_B = \int \vec{B}\cdot d\vec{A}$$

$$\mathscr{E}_{\text{ind}} = \oint \vec{E}\cdot d\vec{s} = -\tfrac{d\Phi_B}{dt}$$

$$\mathscr{E} = -L\tfrac{dI}{dt}$$

$$U = \tfrac{1}{2}LI^2$$

$$Q(t) = Q_0 e^{-\gamma t}\cos(\omega t + \phi)$$

$$\omega = \sqrt{1/LC - R^2/4L^2} = \sqrt{\omega_0^2 - \gamma^2}$$

$$X_C = 1/\omega C$$

$$X_L = \omega L$$

$$V = IZ$$

$$\cos(\phi) = \tfrac{R}{Z}$$

$$Z_{\ldots} = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\vec{S} = \tfrac{1}{\mu_0}\vec{E}\times\vec{B}$$

$$\langle S\rangle = c\langle u\rangle = \epsilon_0 cE^2 = \tfrac{cB^2}{\mu_0}$$

$$u = \tfrac{1}{2}\left(\epsilon_0 E^2 + \tfrac{1}{\mu_0}B^2\right)$$

$$P = \tfrac{\langle S\rangle}{c}$$

$$\langle S\rangle = \tfrac{\mathcal{P}}{A}$$

$$U = pc$$

$$\Delta p = \tfrac{\Delta U}{c}$$

$$\vec{x}_f = \tfrac{1}{2}\vec{a}t^2 + \vec{v}_i t + \vec{x}_i$$

$$\vec{v}_f = \vec{a}t + \vec{v}_i$$

$$\sum \vec{F} = m\vec{a} = \tfrac{d\vec{p}}{dt}$$

$$a_c = \tfrac{v^2}{r}$$

$$W = \int \vec{F}\cdot d\vec{s}$$

$$\vec{g} = -\frac{GM}{r^2}\hat{r}$$

$$A_\Delta = \tfrac{1}{2}bh$$

$$dV_{\text{ball}} = 4\pi r^2 dr$$

$$dA_{\text{sphere}} = 2\pi r dr$$