

**Equations**

$$\vec{F}_E = q\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{q_1q_2}{r^2} \hat{r}$$

$$\vec{F}_B = q\vec{v} \times \vec{B}$$

$$|\vec{F}|_B = |q|vB = \frac{mv^2}{r}$$

$$d\vec{F}_B = id\vec{l} \times \vec{B}$$

$$\vec{E} = \frac{\vec{F}}{q} = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \hat{r}$$

$$d\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{dq}{r^2} \hat{r}$$

$$= \frac{1}{4\pi\epsilon_0} \frac{\lambda dr}{r^2} \hat{r}$$

$$\vec{E} = \frac{1}{2\pi\epsilon_0} \frac{\bar{p}}{z^3}$$

$$d\vec{B} = \frac{\mu_0 id\vec{s} \times \hat{r}}{4\pi r^2}$$

$$B = \frac{\mu_0 i}{2\pi r}$$

$$B = \frac{\mu_0 i\phi}{4\pi r}$$

$$B = \mu_0 in$$

$$B = \frac{\mu_0 iN}{2\pi r}$$

$$\int \vec{B} \cdot d\vec{s} = \mu_0 i_{enclosed}$$

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

$$\vec{p} = q\vec{d}$$

$$\vec{\tau} = \vec{p} \times \vec{E}$$

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

$$V = -\frac{W_\infty}{q}$$

$$\Delta V = -\int_i^f \vec{E} \cdot d\vec{s}$$

$$\vec{E} = -\frac{dV}{dr}$$

$$C_{eq} = \sum^n C_i$$

$$C_{eq} = \frac{1}{\sum^n \frac{1}{C_i}}$$

$$q = CV$$

$$PE = U = \frac{1}{2} CV^2$$

$$= \frac{q^2}{2C} = \frac{1}{2} Li^2$$

$$I = \frac{dq}{dt} = \int \vec{J} \cdot d\vec{A}$$

$$R = \rho \frac{L}{A}$$

$$V = IR$$

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$\epsilon = \frac{dW}{dq} = \int \vec{E} \cdot d\vec{s}$$

$$= -N \frac{d\Phi_B}{dt}$$

$$R_{eq} = \sum^n R_i$$

$$R_{eq} = \frac{1}{\sum^n \frac{1}{R_i}}$$

$$q = C\epsilon \left( 1 - e^{-\frac{t}{RC}} \right)$$

$$V = V_o \left( 1 - e^{-\frac{t}{RC}} \right)$$

$$\tau_c = RC$$

$$\tau_L = \frac{L}{R}$$

$$i = \frac{\epsilon}{R} \left( 1 - e^{-\frac{t}{\tau_L}} \right)$$

$$L = \frac{N\Phi_B}{i}$$

$$\frac{L}{l} = \mu_0 n^2 A$$

$$\epsilon = -L \frac{di}{dt}$$

$$\epsilon_1 = -M \frac{di_2}{dt}$$

$$f = \frac{\omega}{2\pi} = \frac{1}{T}$$

$$L \frac{d^2 q}{dt^2} + \frac{q}{C} = 0$$

$$q(t) = Q \cos(\omega t + \phi)$$

$$i(t) = -\omega Q \sin(\omega t + \phi)$$

$$L \frac{d^2 q}{dt^2} + R \frac{dq}{dt} + \frac{q}{C} = 0$$

$$q(t) = Q e^{-Rt/2L} \cos(\omega' t + \phi)$$

$$\omega = \frac{1}{\sqrt{LC}}$$

$$\omega' = \sqrt{\omega^2 - (R/2L)^2}$$

$$\epsilon = \epsilon_m \sin(\omega_d t)$$

$$i = I_o \sin(\omega_d t - \phi)$$

$$X_L = \omega_d L$$

$$X_C = \frac{1}{\omega_d C}$$

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

$$I = \frac{\epsilon_m}{Z}$$

$$P_{Ave} = I_{rms}^2 R = \epsilon_{rms} I_{rms} \cos\phi$$

$$I_{rms} = \frac{I_o}{\sqrt{2}}$$

**Constants**

$$k = 8.99 \times 10^9$$

$$e = 1.6 \times 10^{-19}$$

$$m_e = 9.1 \times 10^{-31}$$

$$m_p = 1.67 \times 10^{-27}$$

$$\epsilon_o = 8.85 \times 10^{-12}$$

$$\mu_o = 1.26 \times 10^{-6}$$