Equations

$$I = \frac{dq}{dt}, \quad I = \int \overrightarrow{J} \cdot d\overrightarrow{A}, \quad V = IR, \quad R = \frac{\rho l}{A}, \quad \rho = \frac{1}{\sigma} \quad \rho = \frac{m}{e^2 n \tau}, \quad P = IV$$

$$R = R_1 + R_2 + R_3 ... \ , \quad \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$$

$$(charging) \quad Q = Q_0(1 - e^{-\frac{t}{RC}}), \quad \tau = RC, \quad CV = Q, \quad I = \frac{V}{R} e^{-\frac{t}{RC}}$$

$$(discharging) \quad Q = Q_0 e^{-\frac{t}{RC}}, \quad I = -\frac{Q_0}{RC} e^{-\frac{t}{RC}}, \qquad KE = \frac{1}{2} m v^2$$

$$\overrightarrow{F} = q\overrightarrow{v} \times \overrightarrow{B}, \quad n = \frac{BI}{Vle}, \quad qvB = \frac{mv^2}{r}, \quad \omega = 2\pi f, \quad \omega = \frac{v}{r}$$

$$\overrightarrow{F} = I\overrightarrow{l} \times \overrightarrow{B}, \quad d\overrightarrow{F} = Id\overrightarrow{l} \times \overrightarrow{B}, \quad \overrightarrow{\tau} = \overrightarrow{\mu} \times \overrightarrow{B}, \quad \overrightarrow{\tau} = \overrightarrow{r} \times \overrightarrow{F}$$

$$d\overrightarrow{B} = \left(\frac{\mu_0}{4\pi}\right) \frac{Id\overrightarrow{l} \times \overrightarrow{r}}{r^3} = \left(\frac{\mu_0}{4\pi}\right) \frac{Id\overrightarrow{l} \times \hat{r}}{r^2}, \qquad \oint \overrightarrow{B} \cdot \overrightarrow{ds} = \mu_0 I_{enclosed}$$

$$B = \frac{\mu_0 I}{2\pi r} \quad (infinite\ wire)$$

$$B = \frac{\mu_0 I \phi}{4\pi R} \quad (center\ of\ circular\ arc\ of\ angle = \phi)$$

$$B = \frac{\mu_0 I}{2R} \ (center\ of\ whole\ loop), \quad B = \mu_0 nI \ (solenoid), \quad B = \frac{\mu_0 NI}{2\pi r} \ (toroid)$$

$$\overrightarrow{F} = m\overrightarrow{a}, \quad \phi_B = \int \overrightarrow{B} \cdot d\overrightarrow{A}, \quad \varepsilon = \oint \overrightarrow{E} \cdot \overrightarrow{ds} = -\frac{d\phi_B}{dt}, \quad \phi_B = BA \ (sometimes)$$

$$\overrightarrow{F_{12}} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r_{12}^2} \hat{r}_{12} \ \ (Point\ Charge) \ \ \overrightarrow{E} = \overrightarrow{F}/q_{test} = \frac{1}{4\pi\epsilon_0} \frac{q}{r_{12}^2} \hat{r}_{12}$$

$$\Phi = \oint \overrightarrow{E} \cdot d\overrightarrow{A} = \oint \overrightarrow{E} \cdot \hat{n} dA = \frac{q_{enclosed}}{\epsilon_0}, \qquad \Phi = E\ A \ (special\ cases)$$

Constants

$$\mu_0 = 4\pi \times 10^{-7} \ \frac{Tm}{A} \qquad \epsilon_0 = 8.85 \times 10^{-12} \ \frac{C^2}{Nm^2}$$

$$e = 1.60 \times 10^{-19} \ C \qquad M_{proton} = 1.67 \times 10^{-27} \ kg$$