Equations

$$I = \frac{dq}{dt}, \quad I = \int \overrightarrow{J} \cdot d\overrightarrow{A}, \quad V = IR, \quad P = IV, \quad \overrightarrow{F} = m\overrightarrow{a}$$

$$\phi_B = \int \overrightarrow{B} \cdot d\overrightarrow{A}, \quad \varepsilon = -\frac{d\phi_B}{dt}, \quad \phi_B = BA \ (sometimes), \quad \varepsilon = -L\frac{dI}{dt}$$

$$(Increasing) \quad I = I_0(1 - e^{-t/\tau}), \quad \tau = L/R, \quad (decreasing) \quad I = I_0 e^{-t/\tau}$$

$$\overrightarrow{F} = I\overrightarrow{l} \times \overrightarrow{B}, \quad d\overrightarrow{F} = Id\overrightarrow{l} \times \overrightarrow{B}, \quad \phi_E = \int \overrightarrow{E} \cdot d\overrightarrow{A}, \quad \oint \overrightarrow{E} \cdot \overrightarrow{ds} = -\frac{d\phi_B}{dt}$$

$$B = \mu_0 nI \quad (solenoid), \quad L = \mu_0 n^2 Al \quad (solenoid), \quad B = \frac{\mu_0 I}{2\pi r} \quad (infinite\ wire)$$

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

$$B = \frac{\mu_0 I}{2R} \ (center\ of\ whole\ loop), \quad B = \frac{\mu_0 NI}{2\pi r} \ (toroid), \quad KE = \frac{1}{2}mv^2$$

$$U_L = (1/2)\, LI^2, \quad U_C = (1/2)\, CV^2, \quad Work = \int \overrightarrow{F} \cdot d\overrightarrow{l}, \quad Power = \frac{dW}{dt} = Fv$$

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

$$\overrightarrow{\tau} = \overrightarrow{\mu} \times \overrightarrow{B}, \quad \overrightarrow{\tau} = \overrightarrow{r} \times \overrightarrow{F}, \quad \overrightarrow{\mu} = I\overrightarrow{A}$$

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

Constants

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

$c = 3.0 \times 10^8 \ m/s$ $\qquad$ $g = 9.8 \ m/s^2$

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