Laws, Principles, Useful Relationships, and Other Information

Coulomb's Rule $\vec{F}_e = k\frac{q_1 q_2}{r^2}\hat{r}$ Def'n of E-Field $\vec{E} \equiv \frac{\vec{F}}{q}$ E-Field Due to a Point Charge $\vec{E} = k\frac{q}{r^2}\hat{r}$

Electric Potential $\Delta V = -\int \vec{E}\cdot d\vec{s}$ Def'n of Potential $\Delta U \equiv q\,\Delta V$ Potential of a Charge $V = k\frac{q}{r}$

Def'n of Capacitance $C \equiv \frac{Q}{V}$ Capacitance of Parallel Plates $C = \varepsilon_o \frac{A}{d}$

Energy in Capacitors $U = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}C\,V^2$ Energy in E-Fields $u \equiv \frac{U}{vol} = \frac{1}{2}\varepsilon_o E^2$

Capacitors in Series $\frac{1}{C_s} = \sum \frac{1}{C_i}$ Capacitors in Parallel $C_p = \sum C_i$ Def'n of Current $I \equiv \frac{dQ}{dt}$

Def'n of Current Density $j \equiv \frac{I}{A}$ Def'n of Resistance $R = \rho\frac{\ell}{A}$ Ohm's Rule $V = IR$

Electric Power $P = IV = \frac{V^2}{R} = I^2 R$ Resistors in Series $R_s = \sum R_i$ Resistors in Parallel $\frac{1}{R_p} = \sum \frac{1}{R_i}$

RC Charge $q = CV\left(1 - e^{-t/RC}\right)$ RC Discharge $q = CV_o e^{-t/RC}$ Force Between Wires $F_m = \frac{\mu_o}{2\pi}\frac{I_1 I_2}{r}\ell$

Def'n of B-Field $\vec{F} \equiv I\vec{\ell} \times \vec{B}$ Force on a Charge $\vec{F} = q\vec{\upsilon} \times \vec{B}$ B-Field of a Wire $B = \frac{\mu_o I}{2\pi r}$

Def'n of Electric Dipole Moment $\vec{p} \equiv q\vec{d}$ Def'n of Magnetic Dipole Moment $\vec{\mu} \equiv I\vec{A}$

Torque on a Dipole $\vec{\tau} = \vec{p} \times \vec{E}$ or $\vec{\tau} = \vec{\mu} \times \vec{B}$ Potential Energy of a Dipole $U = -\vec{p}\cdot\vec{E}$ or $U = -\vec{\mu}\cdot\vec{B}$

Biot-Savart Rule $\vec{B} = \frac{\mu_o}{4\pi}\int \frac{Id\vec{s} \times \hat{r}}{r^2}$

Magnetic Moment of a Charge $\vec{\mu} = \frac{q}{2m}\vec{L}$ Def'n of Flux $\Phi_B \equiv \int \vec{B}\cdot d\vec{A}$ or $\Phi_E \equiv \int \vec{E}\cdot d\vec{A}$

Gauss's Law for Electricity $\oint \vec{E}\cdot d\vec{A} = \frac{q}{\varepsilon_o}$ Faraday's Law $\oint \vec{E}\cdot d\vec{s} = -\frac{d\Phi_B}{dt}$

Gauss's Law for Magnetism $\oint \vec{B}\cdot d\vec{A} = 0$ Ampere's Law $\oint \vec{B}\cdot d\vec{s} = \mu_o\frac{dq}{dt} + \mu_o\varepsilon_o\frac{d\Phi_e}{dt}$

The Def'n of Inductance $\mathcal{E} \equiv -L\frac{dI}{dt}$ Energy in Inductors $U_L = \frac{1}{2}LI^2$

LR "charging" $I = I_o\left(1 - e^{-\frac{R}{L}t}\right)$ LR "discharging" $I = I_o e^{-\frac{R}{L}t}$ Energy Density in a B-Field $u_m = \frac{B^2}{2\mu_o}$

Physical Constants

$k = 8.99\text{x}10^9 \frac{N\ m^2}{C^2}$ $\varepsilon_o = 8.85\text{x}10^{-12}\frac{C^2}{N\ m^2}$ $e = 1.60\text{x}10^{-19}\,C$ m_e=9.11x10^{-31}kg $\mu_o = 4\pi\text{x}10^{-7}\frac{T\ m}{A}$

Areas and Volumes

sphere: $A = 4\pi r^2$ $V = \frac{4}{3}\pi r^3$ cylinder: $A = 2\pi r\ell + 2\pi r^2$ $V = \pi r^2 \ell$