Laws, Principles, Useful Relationships, and Other Information

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

Def'n of Dipole Moment $\vec{p} \equiv q\vec{d}$ Torque on a Dipole $\vec{\tau} = \vec{p} \times \vec{E}$ Potential Energy $U = -\vec{p} \cdot \vec{E}$

Def'n of Electric Flux $\Phi \equiv \int \vec{E} \cdot d\vec{A}$ Gauss's Law $\oint \vec{E} \cdot d\vec{A} = \frac{q_{enclosed}}{\varepsilon_o}$

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

Potential from E-field $\Delta V = -\int \vec{E} \cdot d\vec{s}$ Potential of a Point Charge $V = k\frac{q}{r}$

Potential Due to a Charge Distribution $V = k\int \frac{dq}{r}$ Calculation of E-field from Potential $E_s = -\frac{dV}{ds}$

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

Addition of Capacitors in Series $\frac{1}{C_s} = \sum \frac{1}{C_i}$ Addition of Capacitors in Parallel $C_p = \sum C_i$

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

Capacitors with Dielectrics $C = \kappa C_o$ Definition of Current $I \equiv \frac{dQ}{dt}$ Free Electron Density $n \equiv \frac{N}{vol}$

Def'n of Current Density $j \equiv \frac{I}{A}$ Drift Velocity $j = ne\upsilon$ Definition of Resistivity $\rho \equiv \frac{m}{\tau n e^2}$

Definition of Resistance $R = \rho\frac{\ell}{A}$ Ohm's Rule $V = IR$ Electric Power $P = IV = \frac{V^2}{R} = I^2R$

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 $q = CV_o e^{-t/RC}$

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=9.1x10^{-31}kg $c = 3.00\text{x}10^8$m/s

Areas and Volumes

sphere:	$A = 4\pi r^2$	$V = \frac{4}{3}\pi r^3$
cylinder:	$A = 2\pi r\ell + 2\pi r^2$	$V = \pi r^2 \ell$
cube:	$A = 6a^2$	$V = a^3$

Resistivity (μΩ·cm)		**Dielectric Constants**		**Free Electron Densities (x10^{28}/m^3)**	
Silver	1.59	Pyrex	5.6	Copper	8.45
Copper	1.7	Teflon	2.1	Silver	5.85
Gold	2.44	Nylon	3.4	Gold	5.90
Aluminum	2.82	Paper	3.7	Aluminum	18.1
Iron	10	Water	80		