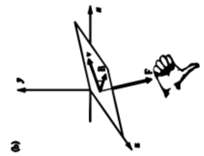
<table>
<tr><td>Voltage for Point Charge, or sphere where $r \geq R$</td><td>$V = \frac{q}{4\pi\epsilon_0 r}$</td><td><u>Electrostatics</u> Units for Volts
$V = \frac{[J]}{[C]}, \vec{E} = \frac{[V]}{[M]}$</td><td>$\oint \vec{E} * d\vec{A} = \frac{Q_{enclosed}}{\epsilon_0}$</td></tr>
<tr><td>$\phi_{Electric} = \int E * \cos\theta * dA$</td><td>$V = \frac{U}{q}$</td><td>$K + U = \frac{1}{2}mv^2 + qV$</td><td>$V = -\int_{P_0}^{P} \vec{E} * d\vec{s} + V_0$</td></tr>
<tr><td>$V = \frac{1}{4\pi\epsilon_0}\int \frac{dQ}{r}$</td><td>$\vec{F} = \frac{k_e q_1 q_2}{r^2}\hat{r}$</td><td>$\overrightarrow{F_{Electric\ Field}} = q\vec{E}$</td><td>$\overrightarrow{E_{field}} = \frac{k_e q}{r^2}\hat{r}$</td></tr>
<tr><td>$\rho_{resistivity} = R\frac{A}{l}$</td><td>$k_e = \frac{1}{4\pi\epsilon_0}$</td><td>Charge on a rod, Uniform
$V(x) = \frac{Q}{4\pi\epsilon_0 l}\ln\left(\frac{x+l}{x}\right)$ or $V(x) = k\lambda\ln\frac{x+l}{x}$</td><td>For Capacitor of Charge Q
$U = \frac{1}{2}QV = \frac{1}{2}CV^2$</td></tr>
<tr><td>$E = -\frac{dV}{ds}$</td><td>Potential of arrangement of charges
$U = \frac{1}{4\pi\epsilon_0} * \frac{q_1 q_2}{r_{12}} + \frac{1}{4\pi\epsilon_0} * \frac{q_1 q_3}{r_{23}} + \frac{1}{4\pi\epsilon_0} * \frac{q_1 q_3}{r_{13}}$</td><td>Capacitor with Dielectric
$C' = \kappa C$</td><td>For parallel plate capacitor | in general
$C = \frac{\epsilon_0 A}{d} \mid C = \frac{Q}{\Delta V}$</td></tr>
<tr><td><u>DC Circuits</u>
$I = \frac{dq}{dt}$</td><td>Parallel Capacitors
$C_{eq} = C_1 + C_2 + \cdots + C_n$</td><td>Parallel Resistors
$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$</td><td>Series Capacitors
$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots + \frac{1}{C_n}$</td></tr>
<tr><td>For conductor of resistivity $R = \frac{\rho l}{A}$</td><td>Drift Velocity
$V_d = \frac{I}{e n_e \pi r^2}$</td><td>Ohmic Heating
$P = I^2 R$</td><td>Series Resistors
$R_{eq} = R_1 + R_2 + \cdots + R_n$</td></tr>
<tr><td><u>Magnetic Field</u> from Current
$\oint \vec{B} * d\vec{s} = \mu_0 I_{enc} \rightarrow Bs = \mu_0 I_{enc}$</td><td>Magnetic Field from a current carrying wire
$B = \frac{\mu_0 I}{2\pi r}$</td><td>Magnetic Field Force
$\vec{F} = q\vec{V} \times \vec{B}$</td><td>Length in terms of radians
$l = r\theta$</td></tr>
<tr><td>Magnetic flux
$\phi_B = \vec{B} \times \vec{A}$</td><td>Force on a current carrying wire in a uniform magnetic field
$F = ILB \mid d\vec{F} = Id\vec{L} \times \vec{B}$</td><td>$\tau(torque) = \mu(mag.d.mnt) \times \vec{B}$ where
$\mu = IA$</td><td>Cyclotron Frequency $f = \frac{qB}{2\pi m}$</td></tr>
<tr><td>Faraday’s Law
$\epsilon_{emf} = -\frac{d\phi_B}{dt}$</td><td>Biot-Savart Law
$d\vec{B} = \frac{\mu I \vec{r} \times d\vec{s}}{4\pi r^3}$</td><td>Force between two parallel wires
$F = \frac{\mu_0 I_2 I_1 L}{2\pi r}$</td><td>Magnetic field in a solenoid
$B = \mu_0\left(\frac{N}{L}\right)I$</td></tr>
<tr><td>Lenz’s Law: “Current induced by EMF always opposes the change in magnetic flux”</td><td><u>Magnetic Induction</u>
Flux through n loop coil, from first
$\phi_B = n\phi_1$</td><td>Magnetic Permeability
$\mu = \mu_0(1 + \chi)$</td><td>Rod connected to circuit moving with velocity through B field
$\epsilon_{emf} = vBL \rightarrow I = \frac{\epsilon}{R} \rightarrow F = IlB$</td></tr>
</table>

Mutual Inductance
$\boldsymbol{\phi_2 = MI_1 \mid \epsilon_2 = -\frac{d\phi_2}{dt} = -\frac{MdI_2}{dt}}$

Emf from bar connected to circuit
$\epsilon = -lvB$



Self-inductance
$\phi = LI \mid \epsilon = -L * \frac{di}{dt}$

Self-inductance for solenoid of length b
$\boldsymbol{L = \mu_0 N^2 \pi r^2 l}$
(N is turns per meter)

AC Circuits
For AC, Max current
$I_{Max} = \omega Q_{CMax}$

"n" turns ratio
$n_{turnsRatio} = \frac{n_p}{n_s}$

$Energy = P_{ower} * \Delta t$

Magnetic fields never do work because they always generate force perpendicular to a charge's motion.

$\boldsymbol{\omega_0 = \frac{1}{\sqrt{LC}}}$

$Z = \frac{V_{RMS}}{I_{RMS}}$

Magnetic field in a capacitor
$\int B * dl = \mu_0 (I_D)_{enclosed}$

Average Power Dissipated
$P = \frac{1}{2} I_0^2 R = \frac{1}{2}\left(\frac{V_0}{Z}\right)^2 R$

$\boldsymbol{Q_C = CV_{MAX}\cos(\omega t)}$

$I_C = -\omega C V_{MAX}(\sin(\omega t)) = -\frac{V_{MAX}\sin(\omega t)}{\frac{1}{\omega C}}$

$I_L = \frac{V_{MAX}\sin(\omega t)}{\omega L}$

$(I_D)_{Enclosed} = I_D\left(\frac{r}{r_0}\right)^2$

Maxwell's Equations/ Electromagnetism
$\boldsymbol{\int \vec{B} * \overrightarrow{ds} = \mu_0 i + \frac{1}{c^2} * \frac{\partial}{\partial t}\int \vec{E} * \overrightarrow{dA}}$

$\oint \vec{B} * d\vec{A} = 0$
"The magnetic flux through any closed surface is zero"

$\int \vec{E} * \overrightarrow{ds} = -\frac{d\phi_B}{dt}$

$P = VI$

Time average energy flux from an Emag Wave
$\boldsymbol{\bar{S} = \frac{1}{2\mu_0 c} E_0^2}$

Pressure of Wave
$[pressure] = \frac{S}{c}(* 2\ for\ full\ reflect)$

Poynting Vector
$S = \frac{1}{\mu_0} E \times B$

$B = \frac{1}{c} * E$

Permittivity $\boldsymbol{\epsilon_0}$
"The ability of a substance to store electrical energy in an electrical field"

Permeability μ
"Measure of the ability of a material to support the formation of a magnetic field within itself"

Em wave intensity
$I = u(density)c$
$I = \frac{P}{4\pi r^2}$

Energy Density
$u = \frac{\epsilon}{2}E^2 + \frac{1}{2\mu}B^2$

Malus' Law $\boldsymbol{\theta}$ is between polarizations
$\boldsymbol{\frac{I_2}{I_1} = \cos^2\theta}$

Unpolarized light → polarizer = ½ original intensity

LC Circuit Energy
$u = \frac{Q^2}{2C} + \frac{LI^2}{2}$

$u = \frac{\bar{S}}{c}$

$\boldsymbol{V_m^2 = V_{mC}^2 + V_{mR}^2 = (X_C^2 + R^2) I_m^2}$

$z = \frac{V_m}{I_m} = \sqrt{\left(\frac{1}{(\omega C)^2}\right) + R^2}$

$Z = R + jQ \rightarrow \sqrt{R^2 + Q^2}$

Quality Factor
$Q = \frac{\omega_0 L}{R}$