Kinematics: $v = v_o + at$; $\Delta x = v_o t + (½)\, a\, t^2$; $v^2 = v_o^2 + 2a(x - x_o)$

Kinetic Energy: $K = \frac{1}{2}mv^2$

Coulomb's law: $F = k\frac{|q_1||q_2|}{r^2} = \frac{1}{4\pi\varepsilon_o}\frac{|q_1||q_2|}{r^2}$

Electric Field: $\vec{E} = \frac{\vec{F}}{q_o}$ $E = \frac{1}{4\pi\varepsilon_o}\frac{|q|}{r^2}$

Gauss's Law for E: $\varepsilon_o \Phi_E = q_{enc}$ where $\Phi_E = \oint \vec{E}\cdot d\vec{A}$

Gauss's Law for B: $\Phi_B = \oint \vec{B}\cdot d\vec{A} = 0$

Potential Difference: $\Delta V = V_b - V_a = -\int_a^b \vec{E}\cdot d\vec{s}$

Potential (point charge): $V = \frac{1}{4\pi\varepsilon_o}\frac{q}{r}$

E from *V*: $\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$

Electric Potential Energy: $U = \frac{1}{4\pi\varepsilon_o}\frac{q_1 q_2}{r}$ (Pair of point charges)

Capacitors: $q = CV$ & $U_E = \frac{1}{2}CV^2 = \frac{q^2}{2C}$ (in general)

$C = \frac{\varepsilon_o A}{d}$ (parallel-plate capacitor) $E = \frac{V}{d}$

$C_{eq} = \sum_{j=1}^{n} C_j$ (parallel) $\frac{1}{C_{eq}} = \sum_{j=1}^{n}\frac{1}{C_j}$ (series)

Current: $i = \frac{dq}{dt} = \int \vec{j}\cdot d\vec{A}$ where $\vec{j} = (ne)\vec{v}_d$

Resistance: $R = \frac{V}{i}$ $\rho = \frac{E}{j}$ $R = \rho\frac{l}{A}$

Power: $P = iV = i^2 R = \frac{V^2}{R}$

Resistors: $R_{eq} = \sum_{j=1}^{n} R_j$ (series) $\frac{1}{R_{eq}} = \sum_{j=1}^{n} \frac{1}{R_j}$ (parallel)

Magnetic Force/Torque: $\vec{F}_B = q\vec{v} \times \vec{B}$ $\vec{F}_B = i\vec{l} \times \vec{B}$ $\vec{\tau} = \vec{\mu} \times \vec{B}$ $|\vec{\mu}| = NiA$

Circulating Charge: $qvB = \frac{mv^2}{r}$ $f = \frac{1}{T} = \frac{qB}{2\pi m}$

Biot-Savart Law: $d\vec{B} = \frac{\mu_o}{4\pi} \frac{i d\vec{l} \times \hat{r}}{r^2}$ or $dB = \frac{\mu_o}{4\pi} \frac{i dl \sin\theta}{r^2}$

Ampere's Law: $\oint \vec{B} \cdot d\vec{l} = \mu_o (i_c + i_d)$ where $i_d = \varepsilon_o \frac{d\Phi_E}{dt}$

Solenoid: $B = \mu_o in$ $L = \mu_o \pi n^2 R^2 l$ $n = N/l$

Faraday's Law: $\varepsilon = \oint \vec{E} \cdot d\vec{s} = -N \frac{d\Phi_B}{dt}$ $\Phi_B = \int \vec{B} \cdot d\vec{A}$ $\varepsilon = vBL$

Inductors: $\mathrm{L} = \frac{N\Phi_B}{i}$ $\varepsilon_L = -\mathrm{L}\frac{di}{dt}$ $U_B = \frac{1}{2}\mathrm{L}i^2$ $u_B = \frac{B^2}{2\mu_o}$

RC Circuits:

Charging Capacitor: $q = C\varepsilon\left(1 - e^{-t/RC}\right)$ $i = \left(\frac{\varepsilon}{R}\right)e^{-t/RC}$

Discharging Capacitor: $q = q_o e^{-t/RC}$ $i = -\left(\frac{q_o}{RC}\right)e^{-t/RC}$

RL Circuits: $i = \frac{\varepsilon}{R}\left(1 - e^{-(R/L)t}\right)$ or $i = I_o e^{-(R/L)t}$

LC Circuits: $\omega = 2\pi f = \frac{2\pi}{T} = \frac{1}{\sqrt{LC}}$ $q = Q\cos\omega t$

Constants:

$c = 3.00 \times 10^8$ m/s (speed of light)

$\varepsilon_o = 8.85 \times 10^{-12}$ $C^2/N \cdot m^2$

$m_p = 1.67 \times 10^{-27}$ kg (proton mass)

$\mu_o = 4\pi \times 10^{-7}$ T · m/A

$k = 1/4\pi\varepsilon_o = 8.99 \times 10^9$ N · m^2/C^2

$m_e = 9.11 \times 10^{-31}$ kg (electron mass)

$e = 1.6 \times 10^{-19}$ C (charge on electron)

g = 9.81 m/s^2

Conversions:

1 MΩ = 10^{+6} Ω 1 gram = 10^{-3} kg 1 mT = 10^{-3} T 1 kV = 1000 V

1 m = 10^2 cm = 10^3 mm = 10^6 μm = 10^9 nm 1 eV = 1.6×10^{-19} J

Geometry:

S (cylinder) = $2\pi rL + 2\pi r^2$ S (sphere) = $4\pi r^2$ A (circle) = πr^2

V (cylinder) = $\pi r^2 L$ V (sphere) = $(4/3)\pi r^3$ C (circle) = $2\pi r$

Calculus: $\frac{d}{dx}\ln x = x^{-1}$ $\int \frac{dx}{x} = \ln x$ $\int x^n dx = x^{n+1}/n+1$ $\frac{d}{dx}e^u = e^u \frac{du}{dx}$