Useful Constants
speed of light $c = 2.998 \times 10^8\ m/s$
basic unit of charge $e = 1.602 \times 10^{-19}\ C$
gravitational constant $G = 6.674 \times 10^{-11}\ N\ m^2/kg^2$
mass of electron: $m_e = 9.109 \times 10^{-31}\ kg$
$\epsilon_o = 8.854 \times 10^{-12}\ C^2/(N\ m^2)$
$\epsilon_o = 8.854\ pF/m$
$k = \frac{1}{4\pi\epsilon_o} = 8.988 \times 10^9\ N\ m^2/C^2$
acc to due gravity (standard) $g = 9.807\ m/s^2$
Sun: $mass = 1.99 \times 10^{30}\ kg$, $radius = 6.96 \times 10^8\ m$
Earth: $mass = 5.97 \times 10^{24}\ kg$, $radius = 6.38 \times 10^6\ m$
Charge densities: $\lambda = Q/length$, $\sigma = Q/area$, $\rho = Q/volume$

Common Powers of 10		
Value	Name	Prefix
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c
10^{-1}	deci	d
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G

Random Physics 1 equations: $\Sigma\vec{F} = m\vec{a}$
If constant acc: $x(t) = x_o + v_{ox}t + \frac{1}{2}a_x t^2$ || $v_x(t) = v_{ox} + a_x t$ || $v_x^2 = v_{ox}^2 + 2a_x\Delta x$
Work and Energy: $W_{a\ to\ b} = \int_a^b \vec{F} \cdot d\vec{l}$ || $K_b = K_a + \Sigma W$ or $(K_b + U_b) = (K_a + U_a) + \Sigma W_{other}$
$K = \frac{1}{2}mv^2$ || Uniform circular motion: $a_c = v^2/r$ || Period: $T = 2\pi r/v$

Coulomb's Law: $F = k|q_1 q_2|/r^2$. Matching signs repel; different signs attract.

Flux: $\Phi_E = \int \vec{E} \cdot d\vec{A}$. Gauss's Law: $\Phi_E = Q_{encl}/\epsilon_o$ when flux integrated over a closed surface.

Electric field: $\vec{E} = \vec{F}/q_o$. $\vec{E}$ points out from positive charges, in towards negative charges.

Charge Distribution	Point of interest	Electric field
point charge Q	distance r from Q	$E = kQ/r^2$
conducting sphere	outside $(r > R)$ inside $(r < R)$	$E = kQ/r^2$ $E = 0$
nonconducting sphere	outside	$E = kQ/r^2$
infinite wire	distance r from wire	$E = \lambda/(2\pi\epsilon_o r)$
conducting cylinder	outside inside	$E = \lambda/(2\pi\epsilon_o r)$ $E = 0$
infinite sheet	any point	$E = \sigma/(2\epsilon_o)$
pair of sheets of opposite charge	between plates	$E = \sigma/\epsilon_o$
line segment $a = L/2$ line segment $a = L/2$	along axis $\perp$ to midpoint along axis $\perp$ to midpoint	$E = kQ/(x\sqrt{x^2 + a^2})$ $E = 2k\lambda/(x\sqrt{(x/a)^2 + 1})$
ring of radius a	along axis $\perp$ to ring center	$E = kQx/(x^2 + a^2)^{3/2}$
charged disk radius R	along axis $\perp$ to disk center	$E = \frac{\sigma}{2\epsilon_o}(1 - \frac{1}{\sqrt{(R^2/x^2)+1}})$

Geometry:
circle: $C = 2\pi r$, $A = \pi r^2$
sphere: $C = 2\pi r$, $A = 4\pi r^2$, $V = \frac{4}{3}\pi r^3$
cylinder: $A = 2\pi rh$, $V = \pi r^2 h$

Common Integrals:
$\int x^n dx = \frac{x^{n+1}}{n+1}$ for $n \neq -1$
$\int \frac{1}{x} dx = ln(x)$
$\int e^{ax} dx = \frac{1}{a} e^{ax}$
(If you need others I will look them up.)

Potential energy and Potential

$V = U/q_o$ or $U = q_oV$

2 point charges (or equiv): $U = kqq_o/r \qquad V = kq/r$

n point charges (or equiv): $U = kq_o \sum \frac{q_i}{r_i} \qquad V = k \sum \frac{q_i}{r_i}$

distribution: $U = kq_o \int \frac{dq}{r} \qquad V = k \int \frac{dq}{r}$

infinite line of charge: $V = \frac{\lambda}{2\pi\epsilon_o} ln(\frac{r_o}{r})$

cylinder of charge (radius R): $V = \frac{\lambda}{2\pi\epsilon_o} ln(\frac{R}{r})$ (for $r > R$)

ring of radius a, along line $\perp$ to plane of ring: $V = kq/\sqrt{x^2 + a^2}$

Capacitance

$C = Q/V$

parallel plates: $C_o = \epsilon_o A/d$

spherical capacitor: $C_o = 4\pi\epsilon_o \frac{r_a r_b}{r_b - r_a}$

cylindrical capacitor: $C_o = 2\pi\epsilon_o L/ln(r_b/r_a)$

series: $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots$

parallel: $C = C_1 + C_2 + \cdots$

energy stored: $U = \frac{Q^2}{2C} = \frac{1}{2}CV^2 = \frac{1}{2}QV$

energy density: $u = \frac{1}{2}\epsilon_o E^2$

dielectrics: $C = C_oK \qquad E = E_o/K$

Current, Resistance...

$I = dQ/dt = n|q|v_dA$

temperature variation: $\rho = \rho_o[1 + \alpha(T - T_o)]$

Ohm's law: $V_{ba} = IR$ where $R = \rho L/A$

parallel: $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$

series: $R = R_1 + R_2 + \cdots$

EMF ξ: ideal output of source

battery internal resistance: $V_{ba} = \xi - Ir$

Power: $P = V_{ba}I = I^2R = V_{ba}^2/R$

AC: $V = V_o \sin(\omega t) \qquad I = I_o \sin(\omega t)$

$P_{avg} = I_{rms}V_{rms} = I_{rms}^2 R = V_{rms}^2/R$

$I_{rms} = \frac{1}{\sqrt{2}} I_o \qquad V_{rms} = \frac{1}{\sqrt{2}} V_o$

Kirchhoff: Junction (node) rule: $\Sigma I_{in} = \Sigma I_{out}$ Loop rule: $\Sigma \Delta V = 0$

RC circuits: $\tau = RC$

charging: $Q = C\xi(1 - e^{-t/\tau}) \qquad I = dQ/dt = \frac{\xi}{R}e^{-t/\tau} \qquad V_C = Q/C = \xi(1 - e^{-t/\tau})$

discharging: $Q = Q_oe^{-t/\tau} \qquad I = dQ/dt = I_oe^{-t/\tau} \qquad V_C = Q/C = V_oe^{-t/\tau}$

Dielectric Constants (at 20^oC)

Material	Dielectric constant K	Dielectric strength (V/m)
Vacuum	1.0000	
Air (1 atm)	1.0006	3×10^6
Paraffin	2.2	10×10^6
Polystyrene	2.6	24×10^6
Vinyl (plastic)	2 to 4	50×10^6
Paper	3.7	15×10^6
Quartz	4.3	8×10^6
Oil	4	12×10^6
Glass, pyrex	5	14×10^6
Porcelain	6 to 8	5×10^6
Mica	7	150×10^6
Water (liquid)	80	150×10^6

Resistivity and Temperature Coefficients

$\rho = \rho_o[1 + \alpha(T - T_o)]$ where $T_o = 20^oC$

Material	ρ_o $(\Omega \cdot m)$	α $(^oC)^{-1}$
Conductors		
Silver	1.59×10^{-8}	0.0061
Copper	1.68×10^{-8}	0.0068
Gold	2.44×10^{-8}	0.0034
Aluminum	2.65×10^{-8}	0.00429
Tungsten	5.60×10^{-8}	0.0045
Iron	9.71×10^{-8}	0.00651
Platinum	10.60×10^{-8}	0.003927
Mercury	98.00×10^{-8}	0.0009
Nichrome	100.00×10^{-8}	0.0004
Insulators		
Glass	10^9 to 10^{12}	
Hard rubber	10^{13} to 10^{15}	