Constants:

$$
\begin{aligned}
k_e &= \frac{1}{4\pi\epsilon_o} = 8.98755 \times 10^9\ \mathrm{N\cdot m^2\cdot C^{-2}}\\
\mu_o &\equiv 4\pi \times 10^{-7}\ \mathrm{T\cdot m/A}\\
\epsilon_o &= \frac{1}{4\pi k_e} = 8.85 \times 10^{-12}\ \mathrm{C^2/N\cdot m^2}\\
e &= 1.60218 \times 10^{-19}\ \mathrm{C}\\
h &= 6.6261 \times 10^{-34}\ \mathrm{J\cdot s} = 4.1357 \times 10^{-15}\ \mathrm{eV\cdot s} \qquad \hbar = \frac{h}{2\pi}\\
c &= \frac{1}{\sqrt{\mu_0\epsilon_0}} = 2.99792 \times 10^8\ \mathrm{m/s}\\
m_{e^-} &= 9.10938 \times 10^{-31}\ \mathrm{kg} = 0.510998\ \mathrm{MeV}/c^2\\
m_{p^+} &= 1.67262 \times 10^{-27}\ \mathrm{kg} = 938.272\ \mathrm{MeV}/c^2\\
m_{n^0} &= 1.67493 \times 10^{-27}\ \mathrm{kg} = 939.565\ \mathrm{MeV}/c^2\\
hc &= 1239.84\ \mathrm{eV\cdot nm}
\end{aligned}
$$

Quadratic formula:

$$0 = ax^2 + bx^2 + c \Longrightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Basic Equations:

$$
\begin{aligned}
\vec{\mathbf{F}}_{\mathrm{net}} &= m\vec{\mathbf{a}} \text{ Newton's Second Law}\\
\vec{\mathbf{F}}_{\mathrm{centr}} &= -\frac{mv^2}{r}\hat{\boldsymbol{r}} \text{ Centripetal}
\end{aligned}
$$

EM Waves:

$$
\begin{aligned}
c &= \lambda f = \frac{|\vec{E}\,|}{|\vec{B}\,|}\\
I &= \left[\frac{\text{photons}}{\text{time}}\right]\left[\frac{\text{energy}}{\text{photon}}\right]\left[\frac{1}{\text{Area}}\right]\\
I &= \frac{\text{energy}}{\text{time}\cdot\text{area}} = \frac{E_{\max}B_{\max}}{2\mu_0} = \frac{\text{power }(\mathscr{P})}{\text{area}} = \frac{E^2_{\max}}{2\mu_0 c}
\end{aligned}
$$

Electric Potential:

$$
\begin{aligned}
\Delta V &= V_B - V_A = \frac{\Delta \mathrm{PE}}{q}\\
\Delta PE &= q\Delta V = -q|\vec{E}\,||\Delta\vec{x}\,|\cos\theta = -qE_x\Delta x\\
&\quad \uparrow \text{ constant E field}
\end{aligned}
$$

Relativity

$$
\begin{aligned}
\gamma &= 1\Big/\sqrt{1-\frac{v^2}{c^2}}\\
\Delta t'_{\mathrm{moving}} &= \gamma\Delta t_{\mathrm{stationary}} = \gamma\Delta t_p\\
L'_{\mathrm{moving}} &= \frac{L_{\mathrm{stationary}}}{\gamma}\\
\Delta t' &= t'_1 - t'_2 = \gamma\left(\Delta t - \frac{v\Delta x}{c^2}\right)\\
v_{\mathrm{obj}} &= \frac{v + v'_{\mathrm{obj}}}{1 + \frac{vv'_{\mathrm{obj}}}{c^2}} \qquad v'_{\mathrm{obj}} = \frac{v_{\mathrm{obj}} - v}{1 - \frac{vv_{\mathrm{obj}}}{c^2}}\\
\mathrm{KE} &= (\gamma - 1)mc^2\\
E_{\mathrm{rest}} &= mc^2 \qquad p = \gamma mv\\
E^2 &= p^2c^2 + m^2c^4
\end{aligned}
$$

Optics/Photons:

$$
\begin{aligned}
E &= hf = \frac{hc}{\lambda}\\
n &= \frac{\text{speed of light in vacuum}}{\text{speed of light in a medium}} = \frac{c}{v}\\
\frac{\lambda_1}{\lambda_2} &= \frac{v_1}{v_2} = \frac{c/n_1}{c/n_2} = \frac{n_2}{n_1} \quad \text{refraction}\\
n_1\sin\theta_1 &= n_2\sin\theta_2 \quad \text{Snell's refraction}\\
\lambda f &= c\\
M &= \frac{h'}{h} = -\frac{q}{p} \quad \text{spherical mirror \& lens}\\
\frac{1}{f} &= \frac{1}{p} + \frac{1}{q} = \frac{2}{R} \quad \text{spherical mirror \& lens}\\
\frac{n_1}{p} + \frac{n_2}{q} &= \frac{n_2 - n_1}{R} \quad \text{spherical refracting}\\
q &= -\frac{n_2}{n_1}p \quad \text{flat refracting}\\
\frac{1}{f} &= \left(\frac{n_2 - n_1}{n_1}\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \quad \text{lensmaker's}
\end{aligned}
$$

Vectors:

$$
\begin{aligned}
|\vec{F}\,| &= \sqrt{F_x^2 + F_y^2} \text{ magnitude}\\
\theta &= \tan^{-1}\left[\frac{F_y}{F_x}\right] \text{ direction}
\end{aligned}
$$

Unit	Symbol	equivalent to
newton	N	kg·m/s^2
joule	J	kg·m^2/s^2 = N·m
watt	W	J/s=m^2·kg/s^3
coulomb	C	A·s
amp	A	C/s
volt	V	W/A = m^2·kg/·s^3·A
farad	F	C/V = A^2·s^4/m^2·kg
ohm	Ω	V/A = m^2·kg/s^3·A^2
tesla	T	Wb/m^2 = kg/s^2·A
electron volt	eV	1.6×10^{-19} J
-	1 T · m/A	1 N/A^2
-	1 T · m^2	1 V · s
-	1 N/C	1 V/m

Power	Prefix	Abbreviation
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T