Cheat Sheet

Constants:

$$\begin{aligned}
k_e &= 8.98755 \times 10^9\ \mathrm{N\cdot m^2\cdot C^{-2}} \\
\epsilon_0 &= 8.85 \times 10^{12}\ \mathrm{C^2/N\cdot m^2} \\
e &= 1.60218 \times 10^{-19}\ \mathrm{C} \\
\mu_0 &\equiv 4\pi \times 10^{-7}\ \mathrm{T\cdot m/A} \\
c &= 2.99792 \times 10^8\ \mathrm{m/s} \\
m_{e-} &= 9.10938 \times 10^{-31}\ \mathrm{kg} \\
m_{p+} &= 1.67262 \times 10^{-27}\ \mathrm{kg}
\end{aligned}$$

Quadratic formula & vectors:

$$\begin{aligned}
0 &= ax^2 + bx^2 + c \Longrightarrow x = \frac{-b \pm \sqrt{b^2-4ac}}{2a} \\
|\vec{\mathbf{F}}| &= \sqrt{F_x^2+F_y^2} \quad \text{magnitude} \\
\theta &= \tan^{-1}\left[\frac{F_y}{F_x}\right] \quad \text{direction}
\end{aligned}$$

Ohm:

$$\begin{aligned}
\Delta V &= IR \\
\mathscr{P} &= E\cdot\Delta t = I\Delta V = I^2R = \frac{[\Delta V]^2}{R} \quad \text{power}
\end{aligned}$$

Induction:

$$\begin{aligned}
\Phi_B &= B_\perp A = BA\cos\theta_{BA} \\
\Delta V &= -N\frac{\Delta\Phi_B}{\Delta t} \\
L &= N\frac{\Delta\Phi_B}{\Delta I} = \frac{N\Phi_B}{I} \\
\Delta V &= |\vec{\mathbf{v}}||\vec{\mathbf{B}}|l = |\vec{\mathbf{E}}|l \quad \text{motional voltage}
\end{aligned}$$

Optics:

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

Magnetic fields & forces:

$$\begin{aligned}
|\vec{\mathbf{F}}_B| &= q|\vec{\mathbf{v}}||\vec{\mathbf{B}}|\sin\theta_{vB} \quad \text{charge } q \\
|\vec{\mathbf{F}}_B| &= BIl\sin\theta \quad \text{wire} \\
|\vec{\boldsymbol{\tau}}| &= BIAN\sin\theta \quad \text{torque current loop} \\
\vec{\mathbf{B}} &= \frac{\mu_0 I}{2\pi r}\,\hat{\theta} \quad \text{wire} \\
\vec{\mathbf{B}} &= \mu_0\frac{N}{L}I\,\hat{\mathbf{z}} \equiv \mu_0 nI\,\hat{\mathbf{z}} \quad \text{solenoid} \\
\frac{|\vec{\mathbf{F}}_{12}|}{l} &= \frac{\mu_0 I_1 I_2}{2\pi d} \quad \text{2 wires, force per length}
\end{aligned}$$

ac Circuits

$$\begin{aligned}
\tau &= L/R \quad \text{RL circuit} \\
\tau &= RC \quad \text{RC circuit} \\
\omega_{\text{cutoff}} &= \frac{1}{\tau} = 2\pi f_{\text{cutoff}} \\
X_C &= \frac{1}{2\pi fC} \quad \text{“resistance” of a capacitor for ac} \\
X_L &= 2\pi fL \quad \text{“resistance” of an inductor for a}
\end{aligned}$$

Units

$$\begin{aligned}
1\,\mathrm{T\cdot m/A} &= 1\,\mathrm{N/A^2} \\
1\,\mathrm{T\cdot m^2} &= 1\,\mathrm{V\cdot s} \\
1\,\mathrm{T} &= 1\,\mathrm{kg/A\cdot s^2} \\
1\,\mathrm{eV} &= 1.6\times10^{-19}\,\mathrm{J} \\
1\,\mathrm{J} &= 1\,\mathrm{N\cdot m} = 1\,\mathrm{kg\cdot m^2/s^2} \\
1\,\mathrm{N} &= 1\,\mathrm{kg\cdot m/s^2} \\
1\,\mathrm{W} &= 1\,\mathrm{J/s} = 1\,\mathrm{kg\cdot m^2/s^3} \\
1\,\mathrm{F} &= 1\,\mathrm{C/V} \\
1\,\mathrm{C} &= 1\,\mathrm{A/s} \\
1\,\mathrm{N/C} &= 1\,\mathrm{V/m}
\end{aligned}$$

EM Waves:

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

Right-hand rule #1

1. Point the fingers of your right hand along the direction of the velocity.
2. Point your thumb in the direction of the magnetic field $\vec{\mathbf{B}}$.
3. The magnetic force on a positive charge points out from the back of your hand.

Right-hand rule #2:
Point your thumb on your right hand along the wire in the direction of the current. Your fingers naturally curl around the direction of the magnetic field caused by the current, which circulates around the wire.