This equation sheet is to be turned in with your completed test. Write your name here.

$$\mu_0 = 4\pi \times 10^{-7} T\,m/A = 1.26 \times 10^{-6} T\,m/A$$
$$k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9\ N \cdot m^2/C^2$$
$$\epsilon_0 = 8.85 \times 10^{-12}\ C^2/\left(N \cdot m^2\right)$$
$$e = 1.60 \times 10^{-19}\ C$$
$$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$$
$$h = 6.626 \times 10^{-34} J \cdot s$$
$$g = 9.8 m/s^2$$
$$c = 3.00 \times 10^8 m/s$$
$$N_{\mathrm{A}} = 6.02 \times 10^{23}\ \mathrm{mol}^{-1}$$
$$m_{\mathrm{e}} = 9.11 \times 10^{-31}\ kg$$
$$m_{\mathrm{p}} = 1.67 \times 10^{-27}\ kg$$
$$1\ \mathrm{m} = 3.28\ \mathrm{ft}$$
$$1\ \mathrm{lb} = 4.45\ N$$
$$1\ \mathrm{eV} = 1.6 \times 10^{-19} J$$
$$\rho_{\mathrm{aluminum}} = 2.75 \times 10^{-8} \Omega \cdot m$$
$$\rho_{\mathrm{silver}} = 1.47 \times 10^{-8} \Omega \cdot m$$
$$\rho_{\mathrm{copper}} = 1.72 \times 10^{-8} \Omega \cdot m$$
$$\rho_{\mathrm{gold}} = 2.44 \times 10^{-8} \Omega \cdot m$$
$$\rho_{\mathrm{steel}} = 20 \times 10^{-8} \Omega \cdot m$$
$$\vec{C} = \vec{A} \times \vec{B} \rightarrow \text{thumb} = \text{fingers} \times \text{palm}$$
$$F = k\frac{|q_1||q_2|}{r^2}$$
$$dq = i\ dt$$
$$q = ne$$
$$\vec{E} = \frac{\vec{F}}{q_0}$$
$$E = \frac{1}{4\pi\epsilon_0}\frac{|q|}{r^2}$$
$$E = \frac{qz}{4\pi\epsilon_0\left(z^2 + R^2\right)^{3/2}} \quad \text{(ring)}$$
$$E = \frac{\sigma}{2\epsilon_0}\left(1 - \frac{z}{\sqrt{z^2 + R^2}}\right) \quad \text{(disk)}$$
$$\lambda = \frac{Q}{L}$$
$$\sigma = \frac{Q}{A}$$
$$\Phi = \oint \vec{E} \cdot d\vec{A}$$
$$\epsilon_0 \Phi = q_{\mathrm{enc}}$$
$$\epsilon_0 \oint \vec{E} \cdot d\vec{A} = q_{\mathrm{enc}}$$
$$E = \frac{\sigma}{\epsilon_0} \quad \text{(surface)}$$
$$E = \frac{\sigma}{2\epsilon_0} \quad \text{(sheet)}$$
$$E = \frac{\lambda}{2\pi\epsilon_0 r} \quad \text{(line)}$$
$$V \equiv \frac{U}{q} = \frac{-W}{q}$$
$$\Delta V \equiv \frac{K_2 - K_1}{q}$$
$$\Delta V = V_f - V_i = -\int_i^f \vec{E} \cdot d\vec{s}$$
$$V = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$$
$$V = \Sigma_i \frac{1}{4\pi\epsilon_0}\frac{q_i}{r_i}$$
$$V = \int dv = k\int \frac{dq}{r}$$
$$qV = \frac{1}{2}mv^2$$
$$E_s = -\frac{\partial V}{\partial s}$$
$$E_x = -\frac{\partial V}{\partial x}$$
$$E = -\frac{\Delta V}{\Delta x}$$
$$U = \frac{kq_1q_2}{r}$$
$$W = \vec{F} \cdot \vec{d} = q\vec{E} \cdot \vec{d} = qEd\cos\phi$$
$$q = CV$$
$$C = \frac{\epsilon_0 A}{d} \quad \text{parallel}$$
$$E = \frac{Q}{A\epsilon_0}$$
$$C_{\mathrm{eq}} = \Sigma_{j=1}^n C_j$$
$$C_{\mathrm{eq}} = \frac{1}{\Sigma_{j=1}^n \frac{1}{C_j}}$$
$$U = \frac{q^2}{2C} = \frac{1}{2}CV^2$$
$$I \equiv \frac{dq}{dt}$$
$$I = \int \mathbf{J} \cdot d\mathbf{A}$$
$$J = \frac{I}{A}$$
$$V = IR$$
$$\rho \equiv \frac{E}{J}$$
$$\mathbf{E} = \rho\mathbf{J}$$
$$\sigma \equiv \frac{1}{\rho}$$
$$R = \rho\frac{L}{A}$$
$$P = I^2R$$
$$P = \frac{V^2}{R}$$
$$P = \frac{E}{t}$$
$$P = IV$$

$$\begin{aligned}
\mathcal{E} &= \frac{dW}{dq} \\
i &= \frac{\mathcal{E}}{R} \\
R_{\text{eq}} &= \Sigma_{j=1}^{n} R_j \quad \text{(series)} \\
\frac{1}{R_{\text{eq}}} &= \Sigma_{j=1}^{n} \frac{1}{R_j} \quad \text{(parallel)} \\
P_{\text{emf}} &= i\mathcal{E} \\
q &= q_0 e^{-t/RC} \\
T_{1/2} &= RC \ln 2 \\
\vec{F}_B &= q\vec{v} \times \vec{B} \\
F_B &= |q| vB \sin\phi \\
|q| vB &= \frac{mv^2}{r} \\
r &= \frac{mv}{|q|B} \\
T &= \frac{2\pi m}{qB} \\
f &= \frac{qB}{2\pi m} \\
\omega &= \frac{qB}{m} \\
\vec{F}_B &= I\vec{L} \times \vec{B} \\
d\vec{F}_B &= I \; d\vec{L} \times \vec{B} \\
\vec{B} &= \frac{\mu_0}{4\pi} \frac{q \; \vec{v} \times \hat{r}}{r^2} \\
d\vec{B} &= \frac{\mu_0}{4\pi} \frac{I \; d\vec{L} \times \hat{r}}{r^2} \\
B &= \frac{\mu_0 I}{2\pi r} \quad \text{(long straight wire)} \\
B &= \frac{\mu_0 I \phi}{4\pi R} \quad \text{(arc)} \\
F_{ba} &= \frac{\mu_0 L I_a I_b}{2\pi d} \quad \text{(two straight wires)} \\
\oint \vec{B} \cdot d\vec{s} &= \mu_0 I_{\text{enc}} \\
B &= \mu_0 I n \quad \text{(solenoid)} \\
B &= \frac{\mu_0 I N}{2\pi} \frac{1}{r} \quad \text{(toroid)} \\
\Phi_B &= \int \vec{B} \cdot d\vec{A} \quad \text{(magnetic flux)} \\
\Phi_B &= BA \\
\mathcal{E} &= -\frac{d\Phi_B}{dt} \quad \text{(Faraday's Law)} \\
\mathcal{E} &= BLv \\
\oint \vec{E} \cdot d\vec{s} &= -\frac{d\Phi_B}{dt} \\
L &= \frac{N\Phi}{I} \quad \text{(inductance)} \\
\frac{L}{l} &= \mu_0 n^2 A \quad \text{(solenoid)} \\
\mathcal{E}_L &= -L\frac{di}{dt}
\end{aligned}$$

$$\begin{aligned}
L\frac{dI}{dt} + Ri &= \mathcal{E} \\
\tau_L &= \frac{L}{R} \\
I &= I_0 e^{-t/\tau_L} \\
U_B &= \frac{1}{2} L i^2 \\
i_{\text{rms}} &= \frac{i}{\sqrt{2}} \\
V_2 &= \frac{N_2}{N_1} V_1 \\
E &= cB \\
\vec{v} &\propto \vec{E} \times \vec{B} \\
c &= \lambda f \\
n &= \frac{c}{v} \\
I &= \frac{1}{2} I_0 \quad \text{(unpolarized)} \\
I &= I_0 \cos^2\theta \quad \text{(polarized)} \\
\theta_1' &= \theta_1 \quad \text{(reflection)} \\
n_2 \sin\theta_2 &= n_1 \sin\theta_1 \quad \text{(refraction)} \\
\theta_c &= \sin^{-1} \frac{n_2}{n_1} \\
s' &= -s \\
f &= \pm\frac{r}{2} \quad \text{(spherical)} \\
\frac{1}{s} + \frac{1}{s'} &= \frac{1}{f} \\
m &= \frac{-s'}{s} \quad \text{(magnification)} \\
\gamma &= \frac{1}{\sqrt{1 - (v/c)^2}} \\
\Delta t &= \gamma \Delta t_0 = \frac{\Delta t_0}{\sqrt{1 - (v/c)^2}} \\
L &= \frac{L_0}{\gamma} = L_0 \sqrt{1 - (v/c)^2} \\
v &= \frac{v_1 + v_2}{1 + v_1 v_2 / c^2} \\
p &= \gamma m v \\
K &= (\gamma - 1)\, mc^2 \\
E &= \gamma mc^2 \\
E &= hf \\
\lambda' - \lambda &= \frac{h}{mc}(1 - \cos\phi) \quad \text{Compton} \\
\lambda &= \frac{h}{p} \\
\Delta x \, \Delta p &\geq \frac{h}{4\pi} \qquad \Delta t \, \Delta E \geq \frac{h}{4\pi}
\end{aligned}$$