

Constants: $e = 1.6 \times 10^{-19} C$ $m_p = 1.67 \times 10^{-27} kg$ $m_e = 9.1 \times 10^{-31} kg$
 $\epsilon_0 = 8.85 \times 10^{-12} C^2/N \cdot m^2$ $1/(4\pi\epsilon_0) = 9 \times 10^9 N \cdot m^2/C^2$ $\mu_0 = 4\pi \times 10^{-7} T \cdot m/A$
 $c = 3 \times 10^8 m/s$ nano = 10^{-9} micro = 10^{-6}

Coulomb's Law: $|\vec{F}| = \frac{|q_1||q_2|}{4\pi\epsilon_0 r^2}$ (point charge)

Electric field: $\vec{E} = \frac{\vec{F}}{q}$ $\vec{E} = \frac{q}{4\pi\epsilon_0 r^2} \hat{r}$ (point charge) $\vec{E} = \int \frac{dq}{4\pi\epsilon_0 r^2} \hat{r}$ (general)

Gauss' law: $\Phi_E = \hat{n} \cdot \vec{E} A = \oint \hat{n} \cdot \vec{E} dA = \frac{q_{enc}}{\epsilon_0}$

Energy: $W = \int \vec{F} \cdot d\vec{s} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = K_f - K_i$

For conservative forces $U_f - U_i = - \int \vec{F} \cdot d\vec{s} \rightarrow K_i + U_i = K_f + U_f$

Electric potential: $V = \frac{U}{q}$ $V = \frac{q}{4\pi\epsilon_0 r}$ (point charge) $V = \int \frac{dq}{4\pi\epsilon_0 r}$ (general)

$V_b - V_a = - \int_a^b E_x dx = - \int_a^b \vec{E} \cdot d\vec{s}$ $E_x = -\frac{\partial V}{\partial x}$, $E_y = -\frac{\partial V}{\partial y}$, $E_z = -\frac{\partial V}{\partial z}$

Capacitors: $q = CV$ $C = \frac{\epsilon_0 A}{d}$ (parallel-plate) $C = C_1 + C_2$ (parallel)

$U_E = \frac{q^2}{2C}$ $u_E = \frac{1}{2}\epsilon_0 E^2$ $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$ (series)

Resistors: $i = \frac{dq}{dt} = jA$ $R = \frac{V}{i}$ $R = \frac{\rho L}{A}$ (wire) $P = iV$

$R = R_1 + R_2$ (series) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ (parallel) $\tau_{RC} = RC$

Magnetism: $\vec{F} = q\vec{v} \times \vec{B}$ $\vec{F} = i\vec{L} \times \vec{B}$ $\mu = NiA$ $\vec{r} = \vec{\mu} \times \vec{B}$ $U = -\vec{\mu} \cdot \vec{B}$

$d\vec{B} = \frac{\mu_0}{4\pi} \frac{id\vec{s} \times \hat{r}}{r^2}$ $\oint \vec{B} \cdot d\vec{s} = \mu_0 i_{enc}$ $B = \frac{\mu_0 i}{2\pi R}$ (wire), $\frac{\mu_0 i}{2R}$ (loop center), $\frac{\mu_0 i N}{L}$ (solenoid)

Induction: $\Phi_B = \hat{n} \cdot \vec{B} A = \oint \hat{n} \cdot \vec{B} dA$ $\mathcal{E} = \oint \vec{E} \cdot d\vec{s} = -\frac{d\Phi_B}{dt}$

$L = N\Phi_B/i$ (definition) $L = \mu_0 n^2 Al$ (solenoid) $\mathcal{E} = -L \frac{di}{dt}$ $\mathcal{E}_1 = -M \frac{di_2}{dt}$

$U_B = \frac{1}{2}Li^2$ $u_B = \frac{B^2}{2\mu_0}$ $i = i_o e^{-t/\tau_L}$ $\tau_L = L/R$ $\frac{V_s}{V_p} = \frac{N_s}{N_p}$

AC Circuits: $\omega = \frac{1}{\sqrt{LC}}$ (LC circuit) $\mathcal{E} = \mathcal{E}_m \sin(\omega t)$ $i = I \sin(\omega t - \phi)$ (driven RLC) $I = \frac{\mathcal{E}_m}{Z}$

$\tan \phi = \frac{\omega L - \frac{1}{\omega C}}{R}$ $Z = \sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}$ $v_L = L \frac{di}{dt}$ $v_C = \frac{q}{C}$ $P_{avg} = \frac{1}{2} I \mathcal{E}_m \cos \phi$

Maxwell's Eqs.: $\oint \vec{B} \cdot \hat{n} dA = 0$ $\oint \vec{B} \cdot d\vec{s} = \mu_0 \epsilon_0 \frac{d\Phi_E}{dt} + \mu_0 i_{enc}$ $i_d = \epsilon_0 \frac{d\Phi_E}{dt}$

EM Waves: $c = \frac{E}{B} = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$ $\vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B}$ $I = S_{avg} = \frac{1}{c\mu_0} E_{rms}^2$ $E_{rms} = \frac{E_m}{\sqrt{2}}$ $I = \frac{P_s}{4\pi r^2}$

$I = I_o \cos^2 \theta$ $n_1 \sin \theta_1 = n_2 \sin \theta_2$ $\theta_c = \sin^{-1} \frac{n_2}{n_1}$ $\theta_B = \tan^{-1} \frac{n_2}{n_1}$ $p_r = \frac{I}{c}$ (absorp.), $\frac{2I}{c}$ (refl.)