
Prefixes: 10^{3} kilo k, 10^{6} mega M, 10^{9} giga G, 10^{12} tera T, 10^{15} peta P, 10^{-3} milli m, 10^{-6} micro μ, 10^{-9} nano n, 10^{-12} pico p, 10^{-15} femto f

Constants: $\epsilon_0 = 8.85\times10^{-12}\,\mathrm{C^2/N\cdot m^2}$ $\quad \frac{1}{4\pi\epsilon_0} = k = 8.99\times10^{9}\,\mathrm{N\cdot m^2/C^2}$ $\quad e = 1.602\times10^{-19}\,\mathrm{C}$

$m_e = 9.109\times10^{-31}\,\mathrm{kg}$ $\quad m_p = 1.673\times10^{-27}\,\mathrm{kg}$ $\quad \mu_0 = 4\pi\times10^{-7}\,\mathrm{T\cdot m/A} \approx 1.26\times10^{-6}\,\mathrm{T\cdot m/A}$

$c = \frac{1}{\sqrt{\mu_0\epsilon_0}} = 3.00\times10^{8}\,\mathrm{m/s}$ $\quad 1\,\mathrm{eV} = 1.602\times10^{-19}\,\mathrm{J}$

Electric Charge: $i = \frac{dq}{dt}$ $\quad F = \frac{1}{4\pi\epsilon_0}\frac{|q_1||q_2|}{r^2}$ $\quad q = ne \quad n = \pm1, \pm2, \pm3, \ldots,$

Electric Fields: $\vec{E} = \frac{\vec{F}}{q_0}$ $\quad \vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$ $\quad \vec{p} = q\vec{d}$ $\quad \vec{E}(z) = \frac{1}{2\pi\epsilon_0}\frac{\vec{p}}{z^3}$ $\quad \vec{dE} = \frac{1}{4\pi\epsilon_0}\frac{dq}{r^2}\hat{r}$ $\quad dq = \lambda\, ds$

$dq = \sigma\, dA$ $\quad dq = \rho\, dV$ $\quad \vec{F} = q\vec{E}$ $\quad \vec{\tau} = \vec{p}\times\vec{E}$ $\quad U = -\vec{p}\cdot\vec{E}$

Gauss' Law: $\Phi_E = \int \vec{E}\cdot\vec{dA}$ $\quad \epsilon_0 \oint \vec{E}\cdot\vec{dA} = q_{\text{enc}}$, $\epsilon_0(EA) = q_{\text{enc}} \to E = \frac{\sigma}{\epsilon_0}$,

$\epsilon_0 E(2\pi r h) = q_{\text{enc}} \to E = \frac{\lambda}{2\pi\epsilon_0 r}$, $\epsilon_0(EA + EA) = q_{\text{enc}} \to E = \frac{\sigma}{2\epsilon_0}$, $\epsilon_0 E(4\pi r^2) = q_{\text{enc}} \to E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}$

Electric Potential: $\Delta V = \frac{\Delta U}{q}$ $\quad V_f - V_i = -\int_i^f \vec{E}\cdot\vec{ds}$ $\quad V = \sum_{i=1}^{n} V_i = \frac{1}{4\pi\epsilon_0}\sum_{i=1}^{n}\frac{q_i}{r_i}$ $\quad V = \frac{1}{4\pi\epsilon_0}\frac{p\cos(\theta)}{r^2}$

$V = \frac{1}{4\pi\epsilon_0}\int\frac{dq}{r}$ $\quad E_s = \frac{-\partial V}{\partial s}$ $\quad E_x = \frac{-\partial V}{\partial x}$ $\quad E_y = \frac{-\partial V}{\partial y}$ $\quad E_z = \frac{-\partial V}{\partial z}$ $\quad U = W = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r}$

Capacitance: $q = CV$ $\quad C = \frac{\kappa\epsilon_0 A}{d}$ $\quad C_{\text{eq}} = \sum_{j=1}^{n} C_j$ (parallel) , $\frac{1}{C_{\text{eq}}} = \sum_{j=1}^{n}\frac{1}{C_j}$ (series) ,

$U = \frac{q^2}{2C} = \frac{1}{2}CV^2$ $\quad u = \frac{1}{2}\epsilon_0 E^2$

Current and Resistance: $i = \frac{dq}{dt}$ $\quad i = \int \vec{J}\cdot\vec{dA}$ $\quad i = nAev_d$ $\quad \vec{J} = (ne)\vec{v}_d$ $\quad R = \frac{V}{i}$ $\quad \vec{E} = \rho\vec{J}$

$R = \rho\frac{L}{A}$ $\quad \rho - \rho_0 = \rho_0\alpha(T - T_0)$ $\quad P = iV = i^2 R = \frac{V^2}{R}$

Circuits: $\varepsilon = \frac{dW}{dq}$ $\quad i = \frac{\varepsilon}{R + r}$ $\quad P = iV$ $\quad P_r = i^2 r$ $\quad P_{\text{emf}} = i\varepsilon$ $\quad R_{\text{eq}} = \sum_{j=1}^{n} R_j$ (series) ,

$\frac{1}{R_{\text{eq}}} = \sum_{j=1}^{n}\frac{1}{R_j}$ (parallel) , $q = C\varepsilon(1 - \mathrm{e}^{-t/RC})$ $\quad C\varepsilon = q_0$ $\quad \tau = RC$ $\quad i = \frac{dq}{dt} = \left(\frac{\varepsilon}{R}\right)\mathrm{e}^{-t/RC}$

$V_C = \varepsilon(1 - \mathrm{e}^{-t/RC})$ $\quad q = q_0\mathrm{e}^{-t/RC}$ $\quad i = \frac{dq}{dt} = -\left(\frac{q_0}{RC}\right)\mathrm{e}^{-t/RC}$

Magnetic Fields: $\vec{F}_B = q\,\vec{v}\times\vec{B}$ $F_B = |q|\,v\,B\sin(\phi)$ $|q|\,v\,B = \frac{m v^2}{r}$ $\omega = \frac{2\pi}{T} = 2\pi f = \frac{|q|B}{m}$

$\vec{F}_B = i\,\vec{L}\times\vec{B}$ $d\vec{F}_B = i\,d\vec{L}\times\vec{B}$ $\vec{\mu} = N\,i\,\vec{A}$ $\vec{\tau} = \vec{\mu}\times\vec{B}$ $U = -\vec{\mu}\cdot\vec{B}$

Magnetic Fields Due To Currents: $d\vec{B} = \frac{\mu_0}{4\pi}\frac{i\,d\vec{s}\times\hat{r}}{r^2}$ $B = \frac{\mu_0 i}{2\pi R}$ $B = \frac{\mu_0 i\,\phi}{4\pi R}$ $F_{ba} = \frac{\mu_0 L\,i_a\,i_b}{2\pi d}$

$\oint \vec{B}\cdot d\vec{s} = \mu_0 i_{\text{enc}}$ $B = \mu_0 i\,n$ $n = N/L$ $B = \frac{\mu_0 i\,N}{2\pi}\frac{1}{r}$ $B = \frac{\mu_0 i\,R^2}{2(R^2+z^2)^{3/2}}$ $\vec{B}(z) = \frac{\mu_0}{2\pi}\frac{\vec{\mu}}{z^3}$

Induction and Inductance: $\Phi_B = \int \vec{B}\cdot d\vec{A}$ $\varepsilon = -\frac{d\Phi_B}{dt}$ $\varepsilon = -N\frac{d\Phi_B}{dt}$ $\varepsilon = B\,L\,v$ $\varepsilon = \oint \vec{E}\cdot d\vec{s}$

$\oint \vec{E}\cdot d\vec{s} = -\frac{d\Phi_B}{dt}$ $L = \frac{N\Phi_B}{i}$ $\frac{L}{l} = \mu_0 n^2 A$ $\varepsilon_L = -L\frac{di}{dt}$ $i = \frac{\varepsilon}{R}(1-\mathrm{e}^{-t/\tau_L})$ $\tau_L = L/R$

$i = i_0\,\mathrm{e}^{-t/\tau_L}$ $U_B = \frac{1}{2}L i^2$ $u_B = \frac{B^2}{2\mu_0}$ $M_{21} = \frac{N_2\Phi_{21}}{i_1}$ $M_{21} = M_{12} = M$ $\varepsilon_2 = -M\frac{di_1}{dt}$ $\varepsilon_1 = -M\frac{di_2}{dt}$

Electromagnetic Oscillations: $L\frac{d^2q}{dt^2} + \frac{1}{C}q = 0$ $q = Q\cos(\omega t+\phi)$ $\omega = \frac{1}{\sqrt{LC}}$

$i = -\omega Q\sin(\omega t+\phi)$ $L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + \frac{1}{C}q = 0$ $q = Q\,\mathrm{e}^{-Rt/2L}\cos(\omega' t+\phi)$ $\omega' = \sqrt{\omega^2 - \left(\frac{R}{2L}\right)^2}$

Maxwell's Equations: $\oint \vec{E}\cdot d\vec{A} = \frac{q_{\text{enc}}}{\epsilon_0}$ $\oint \vec{B}\cdot d\vec{A} = 0$ $\oint \vec{E}\cdot d\vec{s} = -\frac{d\Phi_B}{dt}$ $\oint \vec{B}\cdot d\vec{s} = \mu_0\epsilon_0\frac{d\Phi_E}{dt} + \mu_0 i_{\text{enc}}$,

$i_d = \epsilon_0\frac{d\Phi_E}{dt}$, $\oint \vec{B}\cdot d\vec{s} = \mu_0 i_{d,\text{enc}} + \mu_0 i_{\text{enc}}$

Electromagnetic Waves: $E = E_m\sin(kx-\omega t)$ $B = B_m\sin(kx-\omega t)$ $c = \frac{E}{B} = \frac{1}{\sqrt{\mu_0\epsilon_0}}$ $\vec{S} = \frac{1}{\mu_0}\vec{E}\times\vec{B}$

$S_{\text{ave}} = I = \frac{1}{c\,\mu_0}E_{\text{rms}}^2$ $E_{\text{rms}} = \frac{E_m}{\sqrt{2}}$ $I = \frac{P_s}{4\pi r^2}$ $p_r = \frac{I}{c}$ $p_r = \frac{2I}{c}$ $I = \frac{1}{2}I_0$ $I = I_0\cos^2\theta$

$n_2\sin\theta_2 = n_1\sin\theta_1$ $\theta_c = \sin^{-1}\frac{n_2}{n_1}$ $\theta_{\text{B}} = \tan^{-1}\frac{n_2}{n_1}$

Images: $\frac{1}{p} + \frac{1}{i} = \frac{1}{f} = \frac{2}{r}$ $\frac{n_1}{p} + \frac{n_2}{i} = \frac{n_2-n_1}{r}$ $\frac{1}{p} + \frac{1}{i} = \frac{1}{f} = (n-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ $m = -\frac{i}{p}$ $|m| = \frac{h'}{h}$

$m_\theta = \frac{25\,\text{cm}}{f}$ $M = m\,m_\theta = -\frac{s}{f_{\text{ob}}}\frac{25\,\text{cm}}{f_{\text{ey}}}$ $m_\theta = -\frac{f_{\text{ob}}}{f_{\text{ey}}}$

Interference: $\lambda_n = \frac{\lambda}{n}$ $d\sin\theta = m\lambda,\ m = 0,1,2,\ldots$ $d\sin\theta = \left(m+\frac{1}{2}\right)\lambda,\ m = 0,1,2,\ldots$

$I = 4I_0\cos^2\left(\frac{1}{2}\phi\right)$, $\phi = \frac{2\pi d}{\lambda}\sin\theta$ $2L = \left(m+\frac{1}{2}\right)\frac{\lambda}{n_2},\ m = 0,1,2,\ldots$ $2L = m\frac{\lambda}{n_2},\ m = 0,1,2,\ldots$

Diffraction: $a\sin\theta = m\lambda,\ m = 1,2,3,\ldots$ $I(\theta) = I_m\left(\frac{\sin\alpha}{\alpha}\right)^2$, $\alpha = \frac{\pi a}{\lambda}\sin\theta$ $\sin\theta = 1.22\frac{\lambda}{d}$

$\theta_{\text{R}} = 1.22\frac{\lambda}{d}$ $I(\theta) = I_m(\cos^2\beta)\left(\frac{\sin\alpha}{\alpha}\right)^2$, $\beta = \frac{\pi d}{\lambda}\sin\theta$ $d\sin\theta = m\lambda,\ m = 0,1,2,\ldots$