Calculus-Based Physics II: Equation Sheet

Part I: Electricity and Magnetism

$F_E = \frac{k|Q_1Q_2|}{r^2}$ $\Delta V_{AB} = \frac{W_{AB}}{Q} = \frac{\Delta PE_E}{Q}$ $P = I\Delta V$ $\Delta V_R = IR$ $\Delta V_C = \frac{Q}{C}$ $Q(t) = Q_{max}\left(1 - e^{-t/\tau}\right)$ $\tau = R_{eq}C$

$Q(t') = Q_o' e^{-t'/\tau'}$ $\vec{E} = \frac{\vec{F}}{Q}$ $E = \frac{k|Q|}{r^2}$ $dQ = \lambda\, d\ell = \sigma dA = \rho dV$ $\oint \vec{E}\cdot\hat{n}\, dA = \frac{Q_{encl}}{\varepsilon_o}$ $\Delta V_{AB} = -\int_A^B \vec{E}\cdot d\vec{\ell}$

$V = \frac{kQ}{r}$ $C = \frac{\kappa\varepsilon_o A}{d}$ $\kappa = \frac{E_{ext}}{E}$ $\vec{F}_B = Q\vec{v}\times\vec{B} = I\int d\vec{\ell}\times\vec{B}$ $\oint \vec{B}\cdot d\vec{\ell} = \mu_o I_{thru}$ $\vec{B} = \frac{\mu_o I}{4\pi}\int \frac{d\vec{\ell}\times\hat{r}}{r^2}$ $B = \frac{\mu_o I}{2\pi r}$

$B = \mu_o nI$ $B = \frac{\mu_o NI}{2\pi r}$ $\vec{\tau} = \vec{\mu}\times\vec{B}$ $\vec{\mu} = NIA\hat{n}$ $I = \int \vec{J}\cdot\hat{n}\, dA$ $U_E = \frac{1}{2}C\Delta V_C^{\,2}$ $u_E = \frac{1}{2}\varepsilon_o E^2$ $U_B = \frac{1}{2}LI^2$

$u_B = \frac{B^2}{2\mu_o}$ $|\Delta V_{ind}| = \left|\frac{d\Phi_B}{dt}\right| = L\left|\frac{dI}{dt}\right|$ $I(t) = I_{max}\left(1 - e^{-t/\tau}\right)$ $\tau = \frac{L}{R_{eq}}$ $I(t') = I_o' e^{-t'/\tau'}$ $Q(t) = Q_{max}\cos(\omega t + \delta)$

$\omega = \frac{1}{\sqrt{LC}}$ $\vec{S} = \frac{1}{\mu_o}\vec{E}\times\vec{B}$ $I = \frac{U}{At} = \frac{P}{A}$ $E = cB$ $\Delta\mathscr{P} = \frac{U}{c}$ or $\frac{2U}{c}$ $\left\langle \sin^2(kx - \omega t)\right\rangle\left\langle \cos^2(kx - \omega t)\right\rangle = \frac{1}{2}$

$\beta = \frac{v}{c}$ $\gamma = \frac{1}{\sqrt{1-\beta^2}}$ $\Delta t = \gamma\Delta t_o$ $L = \frac{L_o}{\gamma}$ $x' = \gamma(x - vt)$ $t' = \gamma\left(t - \frac{vx}{c^2}\right)$

Constants

$e = 1.6\times 10^{-19}\,C$ $k = 9.0\times 10^{9}\,\frac{N\cdot m^2}{C^2}$ $1\,eV = 1.602\times 10^{-19}\,J$ $m_{electron} = 9.1\times 10^{-31}\,kg$

$m_{proton} = 1.67\times 10^{-27}\,kg$ $\varepsilon_o = 8.85\times 10^{-12}\,\frac{C^2}{N\cdot m^2}$ $\mu_o = 4\pi\times 10^{-7}\,\frac{T\cdot m}{A}$ $c = \frac{1}{\sqrt{\varepsilon_o\mu_o}} = 3.0\times 10^{8}\,\frac{m}{s}$

Calculus-Based Physics II: Sundry Equations

Part II: Optics

$$n = \frac{c}{v} \qquad \lambda_n = \frac{\lambda}{n} \qquad n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad \frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$f = \frac{R}{2} \qquad m = -\frac{d_i}{d_o} \qquad I(\theta) = I_o \cos^2\left(\frac{\pi d \sin\theta}{\lambda}\right) \qquad d\sin\theta = m\lambda \qquad d\sin\theta = \left(m + \tfrac{1}{2}\right)\lambda$$

$$I(\theta) = I_o \operatorname{sinc}^2\left(\frac{\pi a \sin\theta}{\lambda}\right) \qquad a\sin\theta = m\lambda \qquad \sin\theta \cong \tan\theta \cong \theta$$

$$2n_f t = m\lambda \qquad \operatorname{sinc}(x) \equiv \frac{\sin(x)}{x} \qquad 2n_f t = \left(m + \tfrac{1}{2}\right)\lambda \qquad \tan\theta_p = \frac{n_t}{n_i}$$

$$I(\theta) = I_o \cos^2\left(\frac{\pi d \sin\theta}{\lambda}\right) \operatorname{sinc}^2\left(\frac{\pi a \sin\theta}{\lambda}\right) \qquad I = \tfrac{1}{2} I_o \qquad I = I_o \cos^2\theta$$

Constants

$$c = \frac{1}{\sqrt{\varepsilon_o \mu_o}} = 3.0 \times 10^8 \ \frac{m}{s} \qquad n_{air} \cong 1 \qquad n_{water} \cong 1.33 \qquad n_{glass} \cong 1.55 \qquad n_{oil} \cong 1.2$$