Starting Equations for Physics 2135

Frequently-Used Official Starting Equations From Engineering Physics I:

$x = x_0 + v_{0x}\Delta t + \frac{1}{2}a_x(\Delta t)^2$ $\quad v_x = v_{0x} + a_x\Delta t$ $\quad v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$ $\quad \sum \vec{F} = m\vec{a}$

$E_f - E_i = (W_{other})_{i\to f}$ $\quad E = K + U$ $\quad W_{net} = \Delta K$ $\quad K = \frac{1}{2}mv^2$ $\quad a_r = \frac{v^2}{r}$ $\quad P_F = \frac{dW_F}{dt}$

$P_F = \vec{F}\cdot\vec{v}$ $\quad E = P_{average}\ t$ $\quad \Delta U = U_f - U_i = -(W_{conservative})_{i\to f}$ $\quad \vec{p} = m\vec{v}$

$\vec{P}_i = \vec{P}_f$ if $\sum \vec{F}_{ext} = 0$ $\quad (W_{external})_{i\to f} = -(W_{conservative})_{i\to f}$ if $\Delta K=0$

Constants

$k = \frac{1}{4\pi\varepsilon_0} = 9\times10^9\ \frac{N\cdot m^2}{C^2}$ $\quad \varepsilon_0 = 8.85\times10^{-12}\ \frac{C^2}{N\cdot m^2}$ $\quad \mu_0 = 4\pi\times10^{-7}\ \frac{T\cdot m}{A}$ $\quad g = 9.8\ \frac{m}{s^2}$

$e = 1.6\times10^{-19} C$ $\quad 1\ eV = 1.6\times10^{-19} J$ $\quad c = 3\times10^8\ \frac{m}{s}$

$m_{electron} = 9.11\times10^{-31} kg$ $\quad m_{proton} = 1.67\times10^{-27} kg$

Electric Force, Field, Potential, and Potential Energy

$F = k\frac{|q_1q_2|}{r_{12}^2}$ $\quad \vec{F} = q\vec{E}$ $\quad E = k\frac{|q|}{r^2}$ $\quad \vec{E} = k\frac{q}{r^2}\hat{r}$ $\quad E_{sheet} = \frac{|\sigma|}{2\varepsilon_0}$

$\vec{p} = q\vec{d}$, from - to + $\quad \vec{\tau} = \vec{p}\times\vec{E}$ $\quad U_{dipole} = -\vec{p}\cdot\vec{E}$ $\quad \Phi_E = \int \vec{E}\cdot d\vec{A}$ $\quad \oint \vec{E}\cdot d\vec{A} = \frac{q_{enclosed}}{\varepsilon_0}$

$\Delta U = q\Delta V = q(V_f - V_i)$ $\quad U_f - U_i = -q\int_i^f \vec{E}\cdot d\vec{\ell}$ $\quad V_f - V_i = -\int_i^f \vec{E}\cdot d\vec{\ell}$ $\quad |\Delta V| = Ed$

$V(r) = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ $\quad U = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r_{12}}$ $\quad V = \frac{1}{4\pi\varepsilon_0}\int\frac{dq}{r}$ $\quad E_x = -\frac{\partial V}{\partial x}$

Circuits

$C = \frac{Q}{V}$ $\quad C = \frac{\kappa\varepsilon_0 A}{d} = \kappa C_0$ $\quad U = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}QV$ $\quad C_{eq} = \sum_i C_i$

$\frac{1}{C_{eq}} = \sum_i \frac{1}{C_i}$ $\quad I_{av} = \frac{\Delta Q}{\Delta t}$ $\quad I = \frac{dQ}{dt}$ $\quad J = \frac{I}{A}$ $\quad \vec{J} = nq\vec{v}_d$ $\quad V = IR$ $\quad \vec{J} = \sigma\vec{E}$

$R = \frac{\rho\ell}{A}$ $\quad \rho = \frac{1}{\sigma}$ $\quad \rho = \rho_0[1 + \alpha(T - T_0)]$ $\quad R_{eq} = \sum_i R_i$ $\quad \frac{1}{R_{eq}} = \sum_i \frac{1}{R_i}$

$P = V\frac{dq}{dt}$ $\quad P = IV = \frac{V^2}{R} = I^2R$ $\quad Q(t) = Q_{final}[1 - \exp(-t/\tau)]$ $\quad Q(t) = Q_0\exp(-t/\tau)$

$\tau = RC$ $\quad \sum I = 0$ at any circuit junction $\quad \sum V = 0$ around any closed circuit loop

Gray shading around equation means I don't recommend that you use it unless you REALLY know what you are doing.

Magnetic Force, Magnetic Fields, Inductance

$\vec{F} = q\vec{v}\times\vec{B}$ $\quad \vec{F} = q\left(\vec{E} + \vec{v}\times\vec{B}\right)$ $\quad \vec{F} = I\vec{L}\times\vec{B}$ $\quad \vec{\mu} = NI\vec{A}$ (N=1 for single loop) $\quad \vec{\tau} = \vec{\mu}\times\vec{B}$

$U = -\vec{\mu}\cdot\vec{B}$ $\quad B = \frac{\mu_0 I}{2\pi r}$ $\quad \oint \vec{B}\cdot d\vec{s} = \mu_0\left(I_{encl} + \kappa\varepsilon_0 \frac{d\Phi_E}{dt}\right)$ $\quad \Phi_B = \int \vec{B}\cdot d\vec{A}$ $\quad \oint \vec{B}\cdot d\vec{A} = 0$

$B = \mu_0 \frac{N}{\ell} I = \mu_0 n I$ $\quad B = \frac{\mu_0 N I}{2\pi r}$ $\quad \vec{B} = \frac{\mu_0}{4\pi}\frac{q\vec{v}\times\hat{r}}{r^2}$ $\quad d\vec{B} = \frac{\mu_0 I}{4\pi}\frac{d\vec{s}\times\hat{r}}{r^2}$ $\quad \varepsilon = -N\frac{d\Phi_B}{dt}$

$\oint \vec{E}\cdot d\vec{s} = -\frac{d\Phi_B}{dt}$ $\quad I_{displ} = \kappa\varepsilon_0 \frac{d\Phi_E}{dt}$

Electromagnetic Waves

$\vec{S} = \frac{1}{\mu_0}\vec{E}\times\vec{B}$ $\quad I = \langle S\rangle = \frac{1}{2}c\ \varepsilon_0 E_{max}^2 = \frac{1}{2}\frac{E_{max}^2}{\mu_0 c} = \frac{1}{2}\frac{cB_{max}^2}{\mu_0}$ $\quad \frac{E_{max}}{B_{max}} = \frac{E}{B} = c = \frac{1}{\sqrt{\varepsilon_0\mu_0}}$

$I = \frac{P}{area}$ $\quad u_B = u_E = \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2}\frac{B^2}{\mu_0}$ $\quad \langle u\rangle = \frac{1}{2}\varepsilon_0 E_{max}^2 = \frac{1}{2}\frac{B_{max}^2}{\mu_0}$

$\langle u_B\rangle = \frac{1}{4}\frac{B_{max}^2}{\mu_0}$ $\quad \langle u_E\rangle = \frac{1}{4}\varepsilon_0 E_{max}^2$ $\quad I = \langle S\rangle = c\langle u\rangle$ $\quad \langle P_{rad}\rangle = \frac{I}{c}$ or $\frac{2I}{c}$

$k = \frac{2\pi}{\lambda}$ $\quad \omega = 2\pi f = \frac{2\pi}{T}$ $\quad f\lambda = \frac{\omega}{k} = c$ $\quad T = \frac{1}{f}$

Optics

$v = f\lambda = \frac{\omega}{k}$ $\quad \theta_i = \theta_r$ $\quad n = \frac{c}{v}$ $\quad \lambda_n = \frac{\lambda}{n}$ $\quad n_a \sin\theta_a = n_b \sin\theta_b$

$I = I_{max}\cos^2\phi$ $\quad \frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$ $\quad f = \frac{R}{2}$ $\quad m = \frac{y'}{y} = -\frac{s'}{s}$ $\quad \frac{n_a}{s} + \frac{n_b}{s'} = \frac{n_b - n_a}{R}$ $\quad m = \frac{y'}{y} = -\frac{n_a s'}{n_b s}$

$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\quad m\lambda = d\sin\theta$ $\quad \left(m + \frac{1}{2}\right)\lambda = d\sin\theta$ $\quad \phi = \frac{2\pi}{\lambda}d\sin\theta$ $\quad I_0 = 4I$

$I = I_0\cos^2\left(\frac{\phi}{2}\right)$ $\quad a\sin\theta = m\lambda$ $\quad \beta = \frac{2\pi}{\lambda}a\sin\theta$ $\quad I = I_0\left[\frac{\sin(\beta/2)}{(\beta/2)}\right]^2$ $\quad R = \frac{\lambda_{avg}}{\Delta\lambda} = Nm$

Mathematics

$V_{sphere} = \frac{4}{3}\pi r^3$ $\quad A_{sphere} = 4\pi r^2$ $\quad A_{cylinder} = 2\pi r L$ (excluding ends)