PCS 125 — Formula sheet

(Last modified: April 14, 2018)

Equations

$$\omega = \sqrt{\frac{k}{m}} \qquad \omega = \sqrt{\frac{g}{L}}, \quad \omega = \sqrt{\frac{mgd}{I}} \qquad T = \frac{2\pi}{\omega} = \frac{1}{f}$$

$$\omega = \sqrt{\omega_0^2 - \left(\frac{b}{2m}\right)^2} \qquad A = \frac{F_0/m}{\sqrt{\left(\omega^2 - \omega_0^2\right)^2 + \left(\frac{b\omega}{m}\right)^2}} \qquad x(t) = A\mathrm{e}^{-\frac{bt}{2m}}\cos(\omega t)$$

$$v = \sqrt{\frac{T}{\mu}} \qquad v = f\lambda \qquad v = \sqrt{\frac{B}{\rho}}$$

$$B = -\frac{\Delta P}{\Delta V/V_i} \qquad s(x,t) = s_{\max}\cos(kx - \omega t) \qquad \Delta P_{\max} = \rho v \omega s_{\max}$$

$$\text{Power}_{\text{avg}} = \frac{\rho A \omega^2 s_{\max}^2 v}{2} \qquad I = \frac{\text{Power}}{A} = \frac{\text{Power}}{4\pi r^2} \qquad I = \frac{\Delta P_{\max}^2}{2\rho v}$$

$$\text{Power} = \frac{1}{2}\mu\omega^2 A^2 v \qquad f' = \left(\frac{v + v_O}{v - v_S}\right) f$$

$$v = (331\ \text{m/s})\sqrt{1 + \frac{T_C}{273\ {}^\circ\text{C}}} \qquad \sin(a \pm b) = \sin a \cos b \pm \cos a \sin b \qquad f_{\text{beat}} = |f_2 - f_1|$$

$$\beta = (10\ \text{dB})\log_{10}\left(\frac{I}{I_0}\right) \qquad \sin a \pm \sin b = 2\cos\left(\frac{a \mp b}{2}\right)\sin\left(\frac{a \pm b}{2}\right)$$

$$F = \frac{Gm_1 m_2}{r^2} \qquad U(r) = -\frac{GMm}{r} \qquad F = \frac{kq_1 q_2}{r^2}$$

$$\left|\vec{E}\right| = \frac{\sigma}{2\varepsilon_0} \qquad \Phi_E = \oint \vec{E}\cdot \mathrm{d}\vec{A} = \frac{q_{\text{in}}}{\epsilon_0} \qquad U(r) = \frac{kq_1 q_2}{r}$$

$$E = -\frac{\mathrm{d}V}{\mathrm{d}x} \qquad U_B - U_A = q(V_B - V_A) = -W_{A\to B}^{\text{field}} \qquad W_{A\to B}^{\text{field}} = \int_A^B \vec{F}\cdot \mathrm{d}\vec{r}$$

$$V_B - V_A = -\vec{E}\cdot\vec{r}_{AB} = -El\cos\theta = -Ed$$

$$I_{\text{avg}} = nqv_D A \qquad \Delta V = RI \qquad \text{Power} = \Delta V I$$

$$\vec{F} = q\vec{E} + q\vec{v}\times\vec{B} \qquad \vec{F} = I\vec{L}\times\vec{B}$$

$$V_H = \frac{IB}{nqt} \qquad \vec{B} = \frac{\mu_0 I}{4\pi}\int \frac{\mathrm{d}\vec{s}\times\hat{r}}{r^2} \qquad \frac{F_B}{L} = \frac{\mu_0 I_1 I_2}{2\pi a}$$

$B = \dfrac{\mu_0 I}{2\pi a}$ (at a distance a from an infinitely long wire)

$B = \dfrac{\mu_0 I\theta}{4\pi a}$ (at the centre of an arc wire of radius a subtended by an angle θ)

$B = \dfrac{\mu_0 I a^2}{2\left(a^2 + x^2\right)^{3/2}}$ (at a distance x along the centre line axis of a circular loop of wire of radius a)

Constants

Grav. accel. on Earth	$g = 9.81\ \mathrm{m \cdot s^{-2}}$
Speed of light in vacuum	$c = 3.00 \times 10^{8}\ \mathrm{m \cdot s^{-1}}$
Gravitational constant	$G = 6.6742 \times 10^{-11}\ \mathrm{N \cdot m^{2} \cdot kg^{-2}}$
Coulomb constant	$k_e = 8.9876 \times 10^{9}\ \mathrm{N \cdot m^{2} \cdot C^{-2}}$
Elementary charge	$e = 1.6022 \times 10^{-19}\ \mathrm{C}$
Electron volt	$\mathrm{eV} = 1.6022 \times 10^{-19}\ \mathrm{J}$
Mass of electron	$m_e = 9.1094 \times 10^{-31}\ \mathrm{kg}$
Mass of proton	$m_p = 1.6726 \times 10^{-27}\ \mathrm{kg}$
Permeability of vacuum	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{T \cdot m \cdot A^{-1}}$
Permittivity of vacuum	$\varepsilon_0 = 8.8542 \times 10^{-12}\ \mathrm{C^{2} \cdot N^{-1} \cdot m^{-2}}$
Density of air	$\rho_{\mathrm{air}} = 1.2\ \mathrm{kg \cdot m^{-3}}$
Threshold of hearing	$I_0 = 1 \times 10^{-12}\ \mathrm{W \cdot m^{-2}}$