

Possibly useful relations:

$$T(K) = T(^{\circ}C) + 273.15$$

$$\Delta V = \beta V_0 \Delta T$$

$$\bar{K} = \frac{1}{2} m \overline{v^2} = \frac{3}{2} kT$$

$$f(v) = 4\pi N \left(\frac{m}{2\pi kT}\right)^{\frac{3}{2}} v^2 e^{-\left(\frac{1}{2} m v^2 / kT\right)}$$

$$Q = mc\Delta T$$

$$Q = mL_f$$

$$\text{adiabatic: } PV^\gamma = \text{const.}$$

$$\epsilon_{\text{Carnot}} = 1 - \frac{T_L}{T_H}$$

$$CP_{\text{ref}}^{\text{Carnot}} = T_L / (T_H - T_L)$$

$$\Delta S = \int \left(\frac{dQ}{T}\right)_{\text{reversible}}$$

$$F = k \frac{Q_1 Q_2}{r^2}$$

$$E = k \frac{Q}{r^2}$$

$$E = \sigma / \epsilon_0$$

$$U = -\vec{p} \cdot \vec{E}$$

$$V = U/q$$

$$V = \sum_i V_i$$

$$C = K \epsilon_0 \frac{A}{d}$$

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \dots$$

$$I = \frac{dQ}{dt}$$

$$\rho = \rho_0 (1 + \alpha \Delta T)$$

$$P = \frac{V^2}{R} = I^2 R$$

$$V = V_0 \sin(2\pi ft)$$

$$R_s = R_1 + R_2 + R_3 \dots$$

$$\tau = RC$$

$$\vec{F} = q\vec{v} \times \vec{B}$$

$$\mu = NIA$$

$$B = \frac{\mu_0 I}{2\pi R} \text{ (straight wire)}$$

$$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$T(^{\circ}F) = \frac{9}{5} T(^{\circ}C) + 32^{\circ}$$

$$PV = nRT$$

$$\text{monoatomic: } E_{\text{int}} = \frac{3}{2} nRT$$

$$Q = \int_{T_1}^{T_2} mc dT$$

$$Q = \Delta E_{\text{int}} + W$$

$$\gamma = C_P / C_V$$

$$CP_{\text{ref}} = \frac{Q_L}{W}$$

$$CP_{\text{hp}}^{\text{Carnot}} = 1 / (1 - T_L / T_H)$$

$$\Delta S_{\text{closed}} \geq 0$$

$$\vec{F}_1 = \vec{F}_{12} + \vec{F}_{13} + \dots$$

$$E = 2k\lambda / r$$

$$\vec{p} = Q\vec{l}$$

$$\int \vec{E} \cdot d\vec{A} = Q_{\text{encl}} / \epsilon_0$$

$$V_B - V_A = - \int \vec{E} \cdot d\vec{l}$$

$$E = - \frac{dV}{dl}$$

$$U = \frac{QV}{2} = \frac{CV^2}{2} = \frac{Q^2}{2C}$$

$$C_p = C_1 + C_2 + \dots$$

$$V = IR$$

$$\sigma = 1/\rho$$

$$P_{\text{ave}} = \frac{1}{2} I_0 V_0 = I_{\text{rms}} V_{\text{rms}}$$

$$I = I_0 \sin(2\pi ft)$$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

$$V_C = \mathcal{E} (1 - e^{-t/\tau})$$

$$r = \frac{mv}{qB}$$

$$\tau = \vec{\mu} \times \vec{B}$$

$$B = \frac{\mu_0 I}{2R} \text{ (center of loop)}$$

$$\mathcal{E}_H = Bv dl$$

$$\Delta L = \alpha L_0 \Delta T$$

$$PV = NkT$$

$$v_{\text{rms}} = \sqrt{\frac{3kT}{m}}$$

$$\Delta N = f(v) dv$$

$$Q = mL_V$$

$$dW = PdV$$

$$\epsilon = \frac{|W|}{|Q_H|} = 1 - \frac{|Q_L|}{|Q_H|}$$

$$CP_{\text{hp}} = \frac{Q_H}{W}$$

$$dS = \frac{dQ}{T}$$

$$S = k \ln W$$

$$\vec{E} = \frac{\vec{F}}{q}$$

$$E = 2\pi k\sigma$$

$$\vec{\tau} = \vec{p} \times \vec{E}$$

$$\phi_E = \int \vec{E} \cdot d\vec{A}$$

$$V = \frac{kQ}{r}$$

$$Q = CV$$

$$C = KC_0$$

$$u = \frac{1}{2} \epsilon_0 E^2$$

$$R = \rho \frac{L}{A}$$

$$P = IV$$

$$I = neAv_d$$

$$I_{\text{rms}} = \frac{I_0}{\sqrt{2}} ; V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$$

$$V = \mathcal{E} - Ir$$

$$Q = Q_0 e^{-t/\tau}$$

$$\vec{F} = I\vec{l} \times \vec{B}$$

$$U = -\vec{\mu} \cdot \vec{B}$$

$$B = \mu_0 nI \text{ (inside solenoid)}$$

$$\int \vec{B} \cdot d\vec{l} = \mu_0 I_{\text{encl}}$$

(over)

$$\Phi_B = \int \vec{B} \cdot d\vec{A}$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$

$$\mathcal{E}_1 = -M \frac{dI_2}{dt}$$

$$U = \frac{1}{2} LI^2$$

$$I = \frac{V_0}{R} (1 - e^{-t/\tau})$$

$$V_0 = I_0 Z$$

$$Z = \sqrt{R^2 + (X_C - X_L)^2}$$

$$\omega_0 = 1/\sqrt{LC}$$

$$\int \vec{B} \cdot d\vec{l} = \mu_0 I_{\text{encl}} + \frac{d\Phi_E}{dt}$$

$$\frac{E}{B} = c$$

$$u = \epsilon_0 E^2 = B^2/\mu_0$$

$$v = \frac{c}{n}; \quad \lambda_n = \frac{\lambda}{n}$$

$$P = 1/f$$

$$f = \frac{v}{\lambda}$$

$$d \sin \theta = m\lambda, \quad m = 0, 1, 2, \dots$$

$$\theta_{\text{min}} = 1.22 \frac{\lambda}{D}$$

$$k = 1.38 \times 10^{-23} \text{ J/K}$$

$$R = kN_A = 0.0821 \frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}}$$

$$1 \text{ cal} = 4.186 \text{ J}$$

$$k = 9.00 \times 10^9 \text{ Nm}^2/\text{C}^2$$

$$c = 3.00 \times 10^8 \text{ m/s}$$

$$\cos \theta = \text{adj./hyp.}$$

$$\mathcal{E} = -N \frac{\Delta\Phi_B}{\Delta t} = \int \vec{E} \cdot d\vec{l}$$

$$\mathcal{E} = Blv$$

$$\mathcal{E}_1 = -L \frac{dI}{dt}$$

$$I = \frac{V_0}{R} (e^{-t/\tau})$$

$$X_L = \omega L$$

$$\cos \phi = R/Z$$

$$k = 2\pi/\lambda$$

$$c = \lambda f$$

$$\vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B}$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\frac{1}{d_0} + \frac{1}{d_i} = \frac{1}{f}$$

$$m = m_1 m_2 m_3 \dots$$

$$d \sin \theta = (m + \frac{1}{2})\lambda, \quad m = 0, 1, 2, \dots$$

$$I = I_0 \cos^2 \theta$$

$$N_A = 6.022 \times 10^{23}$$

$$\text{one atmosphere} = 760 \text{ mm Hg} = 10^5 \text{ Pa}$$

$$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$$

$$\epsilon_0 = 8.85 \times 10^{-12} \frac{\text{C}^2}{\text{Nm}^2}$$

$$\sin \theta = \text{opp./hyp.}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\mathcal{E} = NBA\omega \sin(\omega t)$$

$$d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{d\vec{l} \times \hat{r}}{r^2}$$

$$L_{\text{solenoid}} = \frac{\mu_0 N^2 A}{l}$$

$$u = \frac{B^2}{2\mu_0}$$

$$\tau = L/R$$

$$X_C = 1/\omega C$$

$$P_{\text{ave}} = I_{\text{rms}} V_{\text{rms}} \cos \phi$$

$$\omega = 2\pi f$$

$$c = 1/\sqrt{\mu_0 \epsilon_0}$$

$$S_{\text{ave}} = \frac{E_0 B_0}{2\mu_0}$$

$$\sin \theta_c = n_2/n_1$$

$$\frac{h_i}{h_0} = -\frac{d_i}{d_0} = m$$

$$M = \frac{\theta'}{\theta} = -\frac{f_0}{f_e}$$

$$a \sin \theta = m\lambda, \quad m = 1, 2, 3, \dots$$

$$\tan \theta_p = \frac{n_2}{n_1}$$

$$R = 8.315 \text{ J/mol}\cdot\text{K}$$

$$10^5 \text{ Pa}$$

$$q_e = -1.60 \times 10^{-19} \text{ C}$$

$$\mu_0 = 4\pi \times 10^{-7} \frac{\text{T}\cdot\text{m}}{\text{A}}$$

$$\tan \theta = \sin \theta / \cos \theta$$