PHYS 1302 Equation Sheet

Mechanics

$$F = ma, \quad p = mv, \quad K = \frac{1}{2}mv^2, \quad E = K + U$$

Electricity

$$\boldsymbol{F_e = k\frac{|q_1 q_2|}{r^2}}, \quad \boldsymbol{F_e = qE}, \quad \boldsymbol{E_q = k\frac{|q|}{r^2}}$$

$$\Delta U = q\Delta V, \quad \Delta V = -E\Delta s, \quad u_E = \frac{1}{2}\epsilon_0 E^2$$

$$\boldsymbol{V_q = k\frac{q}{r}}, \quad \boldsymbol{U_q = k\frac{q_1 q_2}{r}}$$

$$C = \frac{Q}{V}, \quad C = \kappa\epsilon_0\frac{A}{d}, \quad E_{cap} = \frac{1}{2}QV$$

Circuits

$$\mathrm{I} = \frac{\Delta \mathrm{Q}}{\Delta t}, \quad V = IR, \quad R = \rho\frac{L}{A}$$

$$\rho = \rho_0(1 + \alpha\Delta\mathrm{T}), \quad R = R_0(1 + \alpha\Delta\mathrm{T})$$

$$P = \frac{\Delta E}{\Delta t}, \quad P = IV$$

$$x_{rms} = \frac{x_{max}}{\sqrt{2}}, \quad P_{av} = I_{rms}V_{rms}$$

$$\mathrm{R}_{eq} = R_1 + R_2 + R_3 + \cdots \text{ (Series)}$$

$$\frac{1}{\mathrm{C}_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots \text{ (Series)}$$

$$\frac{1}{\mathrm{R}_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots \text{ (Parallel)}$$

$$\mathrm{C}_{eq} = C_1 + C_2 + C_3 + \cdots \text{ (Parallel)}$$

$$V = \varepsilon(1 - e^{-t/\tau}), \quad V = V_0 e^{-t/\tau}, \quad \tau = RC$$

Magnetism

$$F_m = qvB\sin\theta, \quad r = \frac{mv}{qB}, \quad u_B = \frac{1}{2\mu_0}B^2$$

$$F_m = ILB\sin\theta, \quad \tau = NIAB\sin\theta$$

$$F_m = \mu_0\frac{I_1 I_2 l}{2\pi d}, \quad B = \frac{\mu_0 I}{2\pi r}, \quad B_{loop} = N\frac{\mu_0 I}{2R}$$

$$B = \mu_0 nI, \quad n = \frac{N}{l}$$

Constants

$$k = 8.9876\times 10^9\ \frac{N\cdot m^2}{C^2}, \quad e = 1.6022\times 10^{-19}C$$

$$m_e = 9.1094\times 10^{-31}\ kg, \quad m_p = 1.6726\times 10^{-27}\ kg$$

$$\epsilon_0 = 8.8542\times 10^{-12}\frac{C^2}{N\cdot \mathrm{m}^2}, \quad \mu_0 = 4\pi\times 10^{-7}\ \frac{T\cdot \mathrm{m}}{\mathrm{A}}$$

$$\mathrm{c} = 2.9979\times 10^8\frac{m}{s}, \quad 1eV = 1.6022\times 10^{-19}\mathrm{J}$$

Magnetic Flux

$$\Phi = BA\cos\theta, \quad \varepsilon = -N\frac{\Delta\Phi}{\Delta t}, \quad |\varepsilon| = L\left|\frac{\Delta \mathrm{I}}{\Delta t}\right|$$

$$\varepsilon = NAB\omega\sin\omega t, \quad |\varepsilon| = Blv, \quad \frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{I_s}{I_p}$$

$$\mathrm{L} = \mu_0 n^2 Al, \quad n = \frac{N}{l}, \quad U_B = \frac{1}{2}LI^2$$

$$I = I_0\left(1 - e^{-t/\tau}\right), \quad I = I_0 e^{-t/\tau}, \quad I_0 = \frac{V}{R}, \quad \tau = \frac{L}{R}$$

Electromagnetic Waves

$$c = f\lambda, \quad f' = f\left(1 \pm \frac{u}{c}\right), \quad u_{EM} = \epsilon_0 E^2 = \frac{B^2}{\mu_0}$$

$$I = \frac{P}{A}, \quad I = cu_{EM}, \quad E = cB, \quad c = \frac{1}{\sqrt{\mu_0\epsilon_0}}$$

Geometrical Optics

$$f = \pm\frac{1}{2}R, \quad \frac{1}{f} = \frac{1}{d_0} + \frac{1}{d_i}, \quad m = \frac{h_i}{h_o} = -\frac{d_i}{d_0}$$

$$v_n = \frac{c}{n}, \quad \lambda_n = \frac{\lambda}{n}, \quad n_1\sin\theta_1 = n_2\sin\theta_2$$

Wave Optics

$$\Delta l = m\lambda, \quad \Delta l = \left(m - \frac{1}{2}\right)\lambda, \quad y = L\tan\theta$$

$$\boldsymbol{d}\sin\theta = m\lambda, \quad \boldsymbol{d}\sin\theta = \left(m \pm \frac{1}{2}\right)\lambda$$

$$D\sin\theta = m\lambda, \quad \boldsymbol{d}\sin\theta = m\lambda, \quad d = \frac{1}{N}$$

$$\frac{2d}{\lambda_n} = m + \frac{1}{2}, \quad \frac{2d}{\lambda_n} = m$$

$$\frac{2d}{\lambda_n} = m, \quad \frac{2d}{\lambda_n} = m - \frac{1}{2}$$

$$I = \frac{1}{2}I_0, \quad I = I_0\cos^2\theta, \quad \tan\theta_B = \frac{n_1}{n_2}$$

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

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Quantum Physics

$$E = hf, \quad E = pc, \quad c = f\lambda$$

$$K_{max} = hf - W_0, \quad f_0 = \frac{W_o}{h}$$

$$\boldsymbol{\lambda = \frac{h}{p}}, \quad \boldsymbol{\Delta\lambda = \frac{h}{m_e c}(1 - \cos\theta)}$$

$$\Delta p \Delta y \geq \frac{h}{4\pi}, \quad \Delta E \Delta t \geq \frac{h}{4\pi}$$

Atomic Physics

$$\frac{1}{\lambda} = R_B\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right), \quad n_i > n_f$$

$$L_n = r m_e v_n = \frac{nh}{2\pi}$$

$$r_n = \alpha_B \frac{n^2}{Z}, \quad \alpha_B = \frac{h^2}{4\pi^2 m_e k e^2}$$

$$v_n = \beta_B \frac{Z}{n}, \quad \beta_B = \frac{2\pi k e^2}{h}$$

$$E_n = -E_0 \frac{Z^2}{n^2}, \quad E_0 = \frac{2\pi^2 m_e k^2 e^4}{h^2} = 13.6\ eV$$

$$K(n=1), \ L(n=2), \ M(n=3), \ N(n=4)$$

$$s(l=0), \ p(l=1), \ d(l=2), \ f(l=3)$$

Nuclear Physics

$$E = |\Delta m| c^2, \quad r = (1.2\ fm) A^{1/3}$$

$$N = N_0 e^{-\lambda t}, \quad T_{1/2} = \frac{\ln 2}{\lambda}$$

$$R = \frac{\Delta N}{\Delta t}, \quad R = R_0 e^{-\lambda t}, \quad R_0 = \lambda N_0$$

Temperature and The Ideal Gas

$$T_F = \frac{9}{5} T_C + 32, \ T_C = \frac{5}{9}(T_F - 32), \quad T = T_C + 273.15$$

$$\Delta L = \alpha L_0 \Delta T, \quad \Delta A \approx 2\alpha A_0 \Delta T, \quad \Delta V = \beta V_0 \Delta T, \quad \beta \approx 3\alpha$$

$$PV = N k_B T, \quad PV = nRT, \quad U = \frac{3}{2} NkT$$

$$K_{av} = \left(\frac{1}{2} m v_{av}^2\right) = \frac{3}{2} kT, \quad v_{rms} = \sqrt{\frac{3k_B T}{m}} = \sqrt{\frac{3RT}{M}}$$

Heat, and Heat Transfer

$$C = \frac{Q}{\Delta T}, \quad c = \frac{Q}{m\Delta T}, \quad L = \frac{Q}{m}, \quad Q = \frac{kA\Delta T}{L} t$$

$$P = e\sigma A T^4, \quad P_{net} = e\sigma A(T^4 - T_S^4)$$

Thermodynamics

$$\Delta U = Q - W$$

$$W = P\Delta V, \quad W = NkT \ln\left(\frac{V_f}{V_i}\right)$$

$$W = Q_h - Q_c, \quad Eff = \frac{W}{Q_h}, \quad COP = \frac{Q_c}{W}$$

$$W_{max} = Eff_{max} Q_h, \quad Eff_{max} = 1 - \frac{T_c}{T_h}$$

$$\Delta S = \frac{Q}{T}, \quad S = k_B \ln(W)$$

Constants

$$h = 6.6261 \times 10^{-34}\ \text{Js} = 4.1357 \times 10^{-15}\ \text{eV}$$

$$R_B = 1.097 \times 10^7 m^{-1}, \quad m_n = 1.6749 \times 10^{-27}\ kg$$

$$1u = 1.660540 \times 10^{-27} kg = 931.5\ MeV/c^2$$

$$k_B = 1.3806 \times 10^{-23} \frac{J}{K}, \quad N_A = 6.0221 \times 10^{23} mol^{-1}$$

$$R = kN_A = 8.3145 \frac{J}{mol\ K}, \quad 1cal = 4.186J$$

$$\sigma = 5.67 \times 10^{-8} \frac{J}{s\ m^2 K^4}$$