Physics Equation Sheet

1-D Kinematics

$v_f = v_o + at$

$x_f = x_o + v_o t + \frac{1}{2}at^2$

$v_f^2 = v_o^2 + 2a(x_f - x_o)$

2-D Kinematics (Projectiles)

$v_{yf} = v_{yo} + gt$

$y_f = y_o + v_{yo} t + \frac{1}{2}gt^2$

$v_{yf}^2 = v_{yo}^2 + 2g(y_f - y_o)$

$v_{xf} = v_{xo}$

$x_f = x_o + v_{xo} t$

$R = \frac{v_o^2 \sin(2\theta)}{g}$

Newtonian Dynamics

$\sum \vec{F} = m\vec{a}$

$\sum F_x = ma_x$

$\sum F_y = ma_y$

$F_s \leq \mu_s F_N$

$F_k = \mu_k F_N$

$a_C = \frac{v^2}{r}$

$F_C = \frac{mv^2}{r}$

$T = \frac{2\pi r}{v}$

$F_G = \frac{GM_1M_2}{r^2}$

$g = \frac{GM}{r^2}$

$v_{esc} = \sqrt{\frac{2GM}{r}}$

Work and Energy

$W = Fdcos(\theta)$

$KE = \frac{1}{2}mv^2$

$PE_g = mgh$

$PE_s = \frac{1}{2}kx^2$

$\vec{F} = -k\vec{x}$

Linear Momentum

$\vec{p} = m\vec{v}$

$\Delta p = F\Delta t$

$x_{CM} = \sum_{i=1}^{N} \frac{m_i x_i}{M}$

$\sum p_{before} = \sum p_{after}$

$v_A - v_B = -(v'_A - v'_B)$

(elastic collision only)

Rotational Motion

$v = r\omega$

$\omega = \frac{2\pi}{T}$

$a_{tan} = r\alpha$

$\tau = rFsin(\theta)$

$\sum \vec{\tau} = I\vec{\alpha}$

$L = I\omega$

Vibrations and Waves

$E = \frac{1}{2}kA^2$

$T = 2\pi\sqrt{\frac{m}{k}}$ $T = 2\pi\sqrt{\frac{L}{g}}$

$v = \lambda f$

$v = \sqrt{F_T/(m/L)}$

Electricity and Magnetism

$F_e = \frac{kQ_1Q_2}{r^2}$ $E = \frac{kQ}{r^2}$

$V_{ba} = \frac{\Delta PE_{ba}}{q} = -\frac{W_{ba}}{q}$

$C = \frac{Q}{V} = \epsilon_0 \frac{A}{d}$ $E = -\frac{V_{ba}}{d}$

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

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

$V_{ab} = \mathcal{E} - Ir$

$R_{eq} = R_1 + R_2 + R_3 + \cdots$

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$

$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots$

$C_{eq} = C_1 + C_2 + C_3 + \cdots$

$F = IlB\sin\theta$ $F = qvB\sin\theta$

$B = \frac{\mu_0 I}{2\pi r}$ $B = \frac{\mu_0 IN}{l}$

$\Phi_B = BA\cos\theta$

$\mathcal{E} = -N\frac{\Delta\Phi_B}{\Delta t}$ $\mathcal{E} = Blv$

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

Light and Optics

$c = \lambda f$

$f = \frac{r}{2}$

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

$m = \frac{h_i}{h_O} = -\frac{d_i}{d_O}$

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

$\sin\theta_c = \frac{n_2}{n_1}$

Sound

$v_s \approx 331 + 0.60T$

$\beta = 10\log(\frac{I}{I_0})$

$f_n = \frac{nv}{2L}, n = 1, 2, 3 \ldots$

$f_n = \frac{nv}{4L}, n = 1, 3, 5 \ldots$

$f' = \frac{f}{(1 \pm \frac{v_{source}}{v_{sound}})}$

$f' = \left(1 \pm \frac{v_{obs}}{v_{sound}}\right) f$

Thermodynamics

$\Delta U = Q - W$

$W = P\Delta V$

$Q_H = W + Q_L$

$e = \frac{W}{Q_H} \qquad e_{ideal} = \frac{T_H - T_L}{T_H}$

$COP = \frac{Q_L}{W}$ or $\frac{Q_H}{W}$

$COP_{ideal} = \frac{T_L}{T_H - T_L}$

$\Delta S_s = \frac{Q}{T}$

Fluids

$P = \frac{F}{A}$

$P = \rho g h \qquad \Delta P = \rho g \Delta h$

$\frac{F_{in}}{F_{out}} = \frac{A_{in}}{A_{out}}$

$F_B = \rho_F V_F g$

$\frac{V_F}{V_O} = \frac{\rho_O}{\rho_F}$

$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$

$P_1 + \frac{1}{2}\rho_1 v_1^2 + \rho_1 g y_1 = P_2 + \frac{1}{2}\rho_2 v_2^2 + \rho_2 g y_2$

$v = \sqrt{2g(y_2 - y_1)}$

Fundamental Constants

$G = 6.67x10^{-11} Nm^2/kg^2$

$Q_e = 1.6 \times 10^{-19} C$

$k = 9.0 \times 10^9 Nm^2/C^2$

$\epsilon_o = 8.85 \times 10^{-12} C^2/Nm^2$

$\mu_0 = 4\pi\ x\ 10^{-7}\ Tm/A$

$c = 3.00\ x\ 10^8\ m/s$

$m_e = 9.11\ x\ 10^{-31} kg$

$m_p = 1.673\ x\ 10^{-27} kg$

$m_n = 1.675\ x\ 10^{-27} kg$

Useful Unit Conversions

$1\ day = 8.64x10^4 s$

$1\ year = 3.156x10^7 s$

$1\ in = 2.54\ cm$

$1\ m = 3.281\ ft$

$1\ mi = 1.609\ km$

$1\ eV = 1.6 \times 10^{-19}\ J$

$1\ kcal = 4.186\ x\ 10^3 J$

$1\ atm = 1.013\ x\ 10^5 N/m^2\ (Pa)$

$1\ atm = 1.013\ bar$

$1\ atm = 760\ mmHg\ (torr)$

$1\ atm = 14.7\ lb/in^2$

Useful Quantities

$M_{Earth} = 5.98\ x\ 10^{24} kg$

$M_{Sun} = 1.99\ x\ 10^{30} kg$

$M_{Moon} = 7.35\ x\ 10^{22} kg$

$R_{Earth} = 6.38\ x\ 10^6 m$

$R_{Sun} = 6.96\ x\ 10^8 m$

$R_{Moon} = 1.74\ x\ 10^6 m$

$\overline{D}_{ES} = 1.496\ x\ 10^{11} m$

$\overline{D}_{EM} = 3.84\ x\ 10^5 m$

$I_0 = 1.0\ x\ 10^{-12} W/m^2$