EQUATION SHEET

$\Sigma\ \mathbf{F} = m\mathbf{a}$ $\mathbf{A} = A_x\mathbf{i} + A_y\mathbf{j} + A_z\mathbf{k}$ $A = \sqrt{A_x^2 + A_y^2 + A_z^2}$ $\mathbf{A}\cdot\mathbf{B} = AB\cos\theta$ $\mathbf{A}\cdot\mathbf{B} = A_xB_x + A_yB_y + A_zB_z$

$\mathbf{A}\times\mathbf{B} = AB\sin\theta$ $\Delta\mathbf{x} = \mathbf{x}_2 - \mathbf{x}_1$ $\mathbf{v}_{avg} = \frac{\Delta\mathbf{x}}{\Delta t}$ $\mathbf{v} = \frac{d\mathbf{x}}{dt} = \lim_{\Delta t\to 0}\frac{\Delta\mathbf{x}}{\Delta t}$ $\mathbf{a}_{avg} = \frac{\Delta\mathbf{v}}{\Delta t}$ $\mathbf{a} = \frac{d\mathbf{v}}{dt} = \lim_{\Delta t\to 0}\frac{\Delta\mathbf{v}}{\Delta t}$

$\mathbf{r} = \mathbf{r}_o + \mathbf{v}_o t + {}^1/_2\mathbf{a}t^2$ $\mathbf{v} = \mathbf{v}_o + \mathbf{a}t$ $x = x_o + v_{ox}t + \frac{1}{2}a_x t^2$ $v_x^2 = v_{ox}^2 + 2a_x(x - x_o)$ $v_{x\,avg} = \frac{(v_x + v_{ox})}{2}$ $v_x = v_{ox} + a_x t$

$a_c = v^2/r$ $F_s \le \mu_s F_N$ $F_k = \mu_k F_N$ $KE = \frac{1}{2}mv^2$ $W_{net} = \Delta KE$ $W = \mathbf{F}\cdot\mathbf{d}$ $W_{net} = W_{conservative} + W_{nonconservative}$ $W = -\Delta PE$

$E_{mech} = KE + PE$ $PE_{gravity} = mgh$ $PE_{spring} = {}^1/_2kx^2$ $P = W/t$ $F_{spring} = -kx$ $\mathbf{p} = m\mathbf{v}$ $\Sigma\mathbf{F} = \frac{d\mathbf{p}}{dt}$ $\mathbf{I} = \Delta\mathbf{p} = \int\mathbf{F}dt$

$$v_{1f} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_{1i} + \left(\frac{2m_2}{m_1 + m_2}\right)v_{2i} \qquad v_{2f} = \left(\frac{2m_1}{m_1 + m_2}\right)v_{1i} + \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_{2i}$$

$$x_{cm} = \frac{\sum m_i x_i}{\sum m_i} \qquad \mathbf{r}_{cm} = x_{cm}\mathbf{i} + y_{cm}\mathbf{j} + z_{cm}\mathbf{k} \qquad \mathbf{v}_{cm} = \frac{\sum m_i\mathbf{v}_i}{M} \qquad \mathbf{a}_{cm} = \frac{\sum m_i\mathbf{a}_i}{M}$$

$s = r\theta$ $v = r\omega$ $a_t = r\alpha$ $\omega = \lim_{\Delta t\to 0}\frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt}$ $\alpha = \lim_{\Delta t\to 0}\frac{\Delta\omega}{\Delta t} = \frac{d\omega}{dt}$ $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$ $\omega = \omega_0 + \alpha t$

$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$ $I = \sum m_i r_i^2$ $KE_{rot} = \frac{1}{2}I\omega^2$ $\boldsymbol{\tau} = \mathbf{r}\times\mathbf{F}$ $\tau = rF\sin\theta$ $\sum\tau = I\alpha$ $\mathbf{L} = \mathbf{r}\times\mathbf{p}$ $L = I\omega$ $\Sigma\boldsymbol{\tau} = \frac{d\mathbf{L}}{dt}$

$x = A\cos(\omega t + \phi)$ $\omega = 2\pi f$ $T = \frac{1}{f}$ $\omega_{spring} = \sqrt{k/m}$ $\omega_{pend} = \sqrt{g/L}$ $F = G\frac{m_1 m_2}{r^2}$

$$\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{r_1}{r_2}\right)^3 \qquad y = A\sin(kx - \omega t - \phi) \qquad v = f\lambda \qquad f' = \frac{f(v + v_o)}{v - v_s}$$

$PV = nRT$ $P = F/A$ $P = P_0 + \rho gh$ $P + {}^1/_2\rho v^2 + \rho gh = const$

$T_C = T_K - 273.15$ $T_F = \frac{9}{5}T_C + 32^o F$ $\Delta L = \alpha L_o\Delta T$ $\Delta A = 2\alpha A_o\Delta T$ $\Delta V = \beta V_o\Delta T$ $n = \frac{m}{M}$ $k_B = R/N_A$

$T = \frac{2}{3k_B}N(\frac{1}{2}m\bar{v}^2)$ $\frac{1}{2}m\bar{v}^2 = \frac{3}{2}k_B T$ $v_{rms} = \sqrt{\frac{3k_B T}{m}}$ $Q = mc\Delta T$ $Q = mL$

$W = \int PdV$ $dU = Q - W$ $e \equiv \frac{W}{Q_h} = \frac{Q_h - Q_c}{Q_h}$ $e_c \equiv \frac{T_h - T_c}{T_h}$ $\Delta S_{closed} \ge 0$

<u>constants and conversions</u>

milli: $m = 10^{-3}$ micro: $m = 10^{-6}$ nano: $n = 10^{-9}$ pico: $p = 10^{-12}$

g= 9.8 m/s^2 $G = 6.67\text{x}10^{-11}$ N·m^2/kg^2 $k = 9.0\text{x}10^9$ N·m^2/C^2 $k = \frac{1}{4\pi\varepsilon_0}$ $e = 8.85\text{x}10^{-12} C^2/Nm^2$ $\mu_0 = 4\pi\text{x}10^{-7}$ T·m/A

$c = 3.0\text{x}10^8$ m/s $c = 1/\sqrt{\mu_0\varepsilon_0}$ $h = 6.63\text{x}10^{-34}$ J·s $R = 1.097\text{x}10^7$ m^{-1}

$q_e = -1.6\text{x}10^{-19}$ C $q_p = +1.6\text{x}10^{-19}$ C $m_e = 9.11\text{x}10^{-31}$ kg $m_p = 1.67\text{x}10^{-27}$ kg

1eV = $1.6\text{x}10^{-19}$ J $1cal = 4.186J$

1.61 km = 1 mi 1000 m = 1 km $|g| = 9.8$ m/s^2 $360^o = 2\pi$ rad 1 hr = 60 min 1 min = 60 sec

1 N/m^2 = 1 Pa 1 atm = $1.013\text{x}10^5$ Pa $\rho_{water} = 1.0\text{x}10^3$ kg/m^3 $\rho_{blood} = 1.0\text{x}10^3$ kg/m^3

R = 8.315 J/mol·K = 0.082 atm·liter/mol·K $N_A = 6.022\text{x}10^{23}$ mol^{-1} $k = 1.38\text{x}10^{-23}$ J/K

<u>other equations</u>

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$ $A_{circle}=\pi r^2$ $V_{shpere}= 4/3\pi r^3$ $2\pi rad=1rev$ $2\pi rad=360^o$