Physics 190 Formula Sheet (1)

$$\sin\theta = \frac{op}{hy}$$

$$\cos\theta = \frac{ad}{hy}$$

$$\tan\theta = \frac{op}{ad}$$

$$\theta = \arctan\left|\frac{op}{ad}\right|$$

$$(hy)^2 = (op)^2 + (ad)^2$$

$$(\sin\theta)^2 + (\cos\theta)^2 = 1$$

$$\sec\theta = \frac{1}{\cos\theta}$$

$$(\sec\theta)^2 = (\tan\theta)^2 + 1$$

$$v = \frac{dx}{dt}$$

$$a = \frac{dv}{dt}$$

$$v = v_0 + at$$

$$x = x_0 + v_0 t + \frac{1}{2}at^2$$

$$x = x_0 + \frac{1}{2}(v + v_0)t$$

$$x = x_0 + \left(\frac{v^2 - {v_0}^2}{2a}\right)$$

$$v = v_0 - gt$$

$$y = y_0 + v_0 t - \frac{1}{2}gt^2$$

$$y = y_0 + \frac{1}{2}(v + v_0)t$$

$$y = y_0 - \left(\frac{v^2 - {v_0}^2}{2g}\right)$$

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

$$\vec{v}_{ac} = \vec{v}_{ab} + \vec{v}_{bc}$$

$$\vec{v}_{ba} = -\vec{v}_{ab}$$

$$\text{weight} = mg$$

$$g = 9.81\ \text{m/s}^2 \text{ or } 32.0\ \text{ft/s}^2$$

$$\sum_{i=1}^{N}\vec{F}_i = m\vec{a}$$

$$\vec{F}_1 + \vec{F}_2 + \cdots + \vec{F}_N = m\vec{a}$$

$$F_{1x} + F_{2x} + \cdots + F_{Nx} = ma_x$$

$$f_k = \mu_k n$$

$$f_s \le \mu_s n$$

$$W_F = Fx\cos\theta$$

$$W_S = -\left[\frac{1}{2}kx^2 - \frac{1}{2}k{x_0}^2\right]$$

$$\Delta K = W_{Total}$$

$$\Delta K = \frac{1}{2}mv^2 - \frac{1}{2}m{v_0}^2$$

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

$$Pow = \frac{W}{t}$$

$$\Delta U = -W$$

$$\Delta U_g = mgh - mgh_0$$

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

$$F = kx$$

$$\Delta U_S = \frac{1}{2}kx^2 - \frac{1}{2}k{x_0}^2$$

$$\Delta K + \Delta U_g + \Delta U_S = W_F + W_f$$

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

$$\vec{F} = \frac{d\vec{P}}{dt}$$

$$\vec{P} = \vec{P_0}$$

$$P_x = P_{0x}$$

$$P_y = P_{0y}$$

$$K = K_0$$

$$x_{cm} = \frac{x_1 m_1 + x_2 m_2 + \cdots + x_N m_N}{m_1 + m_2 + \cdots + m_N}$$

Physics 190 Formula Sheet (2)

$\theta = \frac{x}{r}$

$\omega = \frac{v}{r}$

$\alpha = \frac{a}{r}$

1 rpm $= 0.105$ rad/s

$\omega = \omega_0 + \alpha t$

$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$

$\theta = \theta_0 + \frac{1}{2}(\omega + \omega_0)t$

$\theta = \theta_0 + \frac{(\omega^2 + {\omega_0}^2)}{2\alpha}$

thin hoop: $I_{cm} = mr^2$

thick hoop: $I_{cm} = \frac{1}{2}m(r_1^2 + r_2^2)$

cylinder/disk: $I_{cm} = \frac{1}{2}mr^2$

sphere: $I_{cm} = \frac{2}{5}mr^2$

thin spherical shell: $I_{cm} = \frac{2}{3}mr^2$

rod about its center: $I_{cm} = \frac{1}{3}mr^2$

rod about its end: $I_{cm} = \frac{1}{12}mr^2$

$I = I_{cm} + md^2$

$K_R = \frac{1}{2}I\omega^2$

$\Delta K_R = \frac{1}{2}I\omega^2 - \frac{1}{2}I{\omega_0}^2$

$\Delta K_T + \Delta K_R + \Delta U_g + \Delta U_S = W_F + W_f$

$\vec{\tau} = RF\sin\theta$, RHR

$\vec{\tau}_1 + \vec{\tau}_2 + \cdots + \vec{\tau}_N = I\vec{\alpha}$

$dW = \tau d\theta$

$\vec{L} = I\vec{\omega}$

$L = mvr\sin\theta$

$\vec{\tau} = \frac{d\vec{L}}{dt}$

$F = \frac{Gm_1m_2}{R^2}$

$G = 6.67 \text{ x } 10^{-11} \ \frac{\text{N m}^2}{\text{kg}^2}$

$U_g = -\frac{Gm_1m_2}{R}$

$\Delta U_g = \left(-\frac{Gm_1m_2}{R}\right) - \left(-\frac{Gm_1m_2}{R_0}\right)$

$E_S = -\frac{Gm_Sm_E}{2R_S}$

$T^2 = \frac{4\pi^2R^3}{Gm}$

$f = \frac{1}{T}$

$\omega = 2\pi f$

$\frac{d^2x}{dt^2} + \omega^2 x = 0$

$x = A\cos(\omega t + \phi)$

$\omega = \sqrt{\frac{k}{m}}$ (mass on a spring)

$\omega = \sqrt{\frac{g}{l}}$ (simple pendulum)

$\omega = \sqrt{\frac{mgl}{I}}$ (physical pendulum)

Physics 190 Formula Sheet (3)

1 cal = 4.19 J

$dQ = mcdT$ or $\Delta Q = mc\Delta T$

$dQ_1 + dQ_2 = 0$

$c_{water} = 1 \ \frac{\text{cal}}{\text{gm }^\circ\text{C}}$

$c_{ice} = 0.5 \ \frac{\text{cal}}{\text{gm }^\circ\text{C}}$

$Q = mL$

$L_{ice} = 79.7 \ \frac{\text{cal}}{\text{gm}}$

$L_{steam} = 540 \ \frac{\text{cal}}{\text{gm}}$

$\frac{Q}{t} = -\frac{\kappa A\left(T_H - T_C\right)}{x}$

$PV = nRT$

$R = 8.31 \ \frac{\text{J}}{\text{mol K}}$

$n = \frac{N}{N_A} = \frac{m}{m_A}$

$N_A = 6.02 \text{ x } 10^{23} \ \frac{\text{particles}}{\text{mol}}$

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

$STP \Rightarrow P = P_{atm} = 1.01 \text{ x } 10^5 \ \text{N/m}^2$

$T = 0 \ ^\circ\text{C} = 273 \text{ K}$

$k_B = \frac{R}{N_A}$

$k_B = 1.38 \text{ x } 10^{-23} \ \text{J/K}$

$P = \frac{2NK}{3V}$

$K = \frac{3}{2}k_B T$

$U = \frac{3}{2}Nk_B T = \frac{3}{2}nRT$

$v_{rms} = \sqrt{\frac{3k_B T}{m}}$

$P = \frac{Nm\left(v_{rms}\right)^2}{3V}$

$dW = PdV$

monatomic: $f = 3$

diatomic: $f = 5$

polyatomic: $f = 6$

$K = \frac{f}{2}k_B T$

$U = \frac{f}{2}Nk_B T = \frac{f}{2}nRT$

$v_{rms} = \sqrt{\frac{f \ k_B T}{m}}$

$P = \frac{Nm\left(v_{rms}\right)^2}{f \ V}$

$C_V = \frac{f}{2}R$

$C_P = \left(\frac{f+2}{2}\right)R$

$C_P - C_V = R$

$dQ = nC_V dT$

$dQ = nC_P dT$

$\gamma = \frac{C_P}{C_V} = \frac{f+2}{f}$

$PV^\gamma = \text{constant}$

$PV^\gamma = P_1 V_1^\gamma$

$dU = dQ - dW$

$W = Q_H - Q_C$

$e = \frac{W}{Q_H}$

$e = 1 - \frac{Q_C}{Q_H}$

$e_{\max} = 1 - \frac{T_C}{T_H}$

$\Delta S = \int \frac{dQ}{T}$