$\vec{x} = \vec{x}_0 + \vec{v}_0 \cdot t + \frac{1}{2} \cdot \vec{a} \cdot t^2$ $\quad$ $\vec{F}_{\text{net}} = m\vec{a} = m\frac{d\vec{v}}{dt}$

$\vec{v} = \vec{v}_0 + \vec{a} \cdot t$ $\quad$ $\vec{F}_{AB} = -\vec{F}_{BA}$

$v^2 = v_0^2 + 2 \cdot a_{\|} \cdot (x - x_0)$ $\quad$ $\vec{W} = m(\vec{g} - \vec{a})$

$\vec{v}(t) = \frac{d\vec{x}}{dt}$ instantaneous $\quad$ $F_{fr} \leq \mu \cdot F_N$

$\Delta\vec{x} = \vec{v}_{AV}\Delta t, \quad \Delta\vec{v} = \vec{a}_{AV}\Delta t$ $\quad$ equilibrium : $\vec{F}_{\text{net}} = \sum_{\text{all}} \vec{F} = 0$

$v = \sqrt{v_x^2 + v_y^2}$ $\quad$ radians : $\Delta\theta \equiv \frac{\text{arclength}}{\text{radius}}$

$v_x = v\cos\theta, v_y = v\sin\theta$ $\quad$ $F_C = m\frac{v^2}{r} = ma_c$

$\theta = \tan^{-1}(v_y/v_x), R = v_i^2 \sin 2\theta_i / g$ $\quad$ $v = \frac{2\pi r}{T} = 2\pi r f = r\omega$

$\vec{x}_{AC} = \vec{x}_{AB} + \vec{x}_{BC}, \vec{v}_{AC} = \vec{v}_{AB} + \vec{v}_{BC}$ $\quad$ $F = G\frac{m \cdot M}{r^2} = g_S m \left(\frac{R_S}{r}\right)^2$

$W = F_{\|} \cdot x = F\cos\theta \cdot x$ $\quad$ 2π radians $= 360^0$

$KE = \frac{1}{2}mv^2 = p^2/2m$ $\quad$ $G = 6.67 \times 10^{-11}\text{Nm}^2/\text{kg}^2$

$PE = mgh$ (close to earth) $\quad$ $g = 9.8\text{m}/s^2, a_y = -g$

$W_{\text{non-cons}} = \Delta KE + \Delta PE$ $\quad$ $R_E = 6.37 \times 10^6$ m

$PE = -G\frac{mM}{r}$, or $PE = \frac{mgh}{(1 + h/R_E)}$ $\quad$ 1 km $= 0.62$ mi

$P = \frac{\Delta W}{\Delta t}$ $\quad$ 1 mile $= 1.61$ km

$$\vec{p} = m\vec{v}, \ \Delta\vec{p} = \vec{p}_f - \vec{p}_i = \vec{F}\Delta t, \ \vec{p}_{1i} + \vec{p}_{2i} = \vec{p}_{1f} + \vec{p}_{2f};$$

$$p_{1ix} + p_{2ix} = p_{1fx} + p_{2fx}, \ p_{1iy} + p_{2iy} = p_{1fy} + p_{2fy}$$

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

$$v = r\omega, \ a = r\alpha$$

$$\omega_f = \omega_i + \alpha t, \ \theta = \omega_i t + \frac{1}{2}\alpha t^2, \ \omega_f^2 = \omega_i^2 + 2\alpha\theta$$

$$\tau = Fr\sin\theta = F_{\perp} r, \ \tau = I\alpha, \ I = \Sigma_i m_i r_i^2, I = \frac{1}{2}MR^2, I = \frac{2}{5}MR^2$$

$$MX_{cm} = \Sigma m_i x_i, \ MY_{cm} = \Sigma m_i y_i, \ M = \Sigma m_i$$

$$\vec{R}_{cm} = (X_{cm}, Y_{cm}), \ PE = MgY_{cm}$$

$$KE_{rotation} = \frac{1}{2}I\omega^2, \ KE_{roll} = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I\omega^2$$

$$L = I\omega, \ \Delta L = L_f - L_i = \tau\Delta t, \ L_i = L_f$$

$$\Sigma_i \tau_i = 0, \ \Sigma_i F_{ix} = 0, \ \Sigma_i F_{iy} = 0$$

I understand that giving or receiving information about the questions or solutions for this exam to or from anyone other than a course staff member before all students have finished the exam is not allowed. Penalties for breaking this rule may include failure in the course and expulsion from the University.

Signature _____ Date _____