PHYS 1211 Fall 2019 Test 3
Equation Sheet

Test 1 equations

$$\Delta\vec{r} = \vec{r}_f - \vec{r}_i \qquad \vec{v}_{\text{avg}} = \frac{\Delta\vec{r}}{\Delta t} \qquad \vec{a}_{\text{avg}} = \frac{\Delta\vec{v}}{\Delta t} \qquad \vec{a}_y = -g\hat{j} \tag{1}$$

$$\Delta t = t_f - t_i \qquad \vec{v} = \frac{d\vec{r}}{dt} \qquad \vec{a} = \frac{d\vec{v}}{dt} \qquad \vec{v}_{\text{avg}} = \frac{1}{2}(\vec{v}_i + \vec{v}_f) \tag{2}$$

$$x_f = x_i + \frac{1}{2}(v_{xi} + v_{xf})(t_f - t_i) \qquad y_f = y_i + \frac{1}{2}(v_{yi} + v_{yf})(t_f - t_i) \tag{3}$$

$$x_f = x_i + v_{xi}(t_f - t_i) + \frac{1}{2}a_x(t_f - t_i)^2 \quad y_f = y_i + v_{yi}(t_f - t_i) + \frac{1}{2}a_y(t_f - t_i)^2 \tag{4}$$

$$v_{xf} = v_{xi} + a_x(t_f - t_i) \qquad v_{yf} = v_{yi} + a_y(t_f - t_i) \tag{5}$$

$$v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i) \qquad v_{yf}^2 = v_{yi}^2 + 2a_y(y_f - y_i) \tag{6}$$

$$\omega = 2\pi/T \qquad s = r\theta \qquad T = \frac{2\pi r}{v} \qquad a_r = \frac{v_t^2}{r} \tag{7}$$

$$\omega_{\text{avg}} = \frac{\Delta\theta}{\Delta t} \qquad \alpha_{\text{avg}} = \frac{\Delta\omega}{\Delta t} \qquad \omega = \frac{d\theta}{dt} \qquad \alpha = \frac{d\omega}{dt} \tag{8}$$

$$\theta_f = \theta_i + \frac{1}{2}(\omega_i + \omega_f)(t_f - t_i) \qquad \theta_f = \theta_i + \omega_i(t_f - t_i) + \frac{1}{2}\alpha(t_f - t_i)^2 \tag{9}$$

$$\omega_f = \omega_i + \alpha(t_f - t_i) \qquad \omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i) \tag{10}$$

$$v_t = r\omega \qquad a_t = r\alpha \tag{11}$$

Test 2 equations

$$\sum \vec{F} = m\vec{a} \qquad \vec{F}_{\text{g}} = -mg\hat{j} \tag{12}$$

$$f_s^{\max} = \mu_s N \qquad f_k = \mu_k N \qquad F_{\text{spring}} = -kx \tag{13}$$

$$|\vec{F}_{\text{grav}}| = G\frac{m_1 m_2}{r^2} \qquad v = \sqrt{\frac{GM}{r}} \qquad T = \frac{2\pi r^{3/2}}{\sqrt{GM}} \tag{14}$$

$$\vec{v}' = \vec{v} - \vec{v}_o \qquad \vec{r}' = \vec{r} - \vec{v}_o t \qquad K = \frac{1}{2}mv^2 \tag{15}$$

$$W = \vec{F} \cdot \vec{s} \qquad W = \underset{1}{\Delta} K \qquad W = \int \vec{F} \cdot d\vec{r} \tag{16}$$

$$P_{\text{avg}} = \frac{W}{\Delta t} = F\cos\phi v_{\text{avg}} = \vec{F}\cdot\vec{v} \quad P = \frac{dW}{dt} \tag{17}$$

Test 3 equations

$$E_f = E_i + W_{\text{NC}} \quad E = K + U \quad W_{\text{C}} = -\Delta U \tag{18}$$

$$F_r = -\frac{dU}{dr} \quad U_G = -\frac{Gm_1m_1}{r} \quad U_g = mgy \quad U_s = \frac{1}{2}kx^2 \tag{19}$$

$$\vec{p} = m\vec{v} \quad \vec{p}_f = \vec{p}_i + \vec{F}_{\text{net}}\Delta t \quad \vec{J} = \int \vec{F}_{\text{net}}dt \tag{20}$$

$$x_{\text{cm}} = \frac{\sum_j x_j m_j}{M} \quad v_{\text{cm}} = \frac{\sum_j v_j m_j}{M} \quad \sum \vec{F} = \frac{d\vec{p}}{dt} \tag{21}$$

$$\vec{P}_i = \vec{P}_f \quad v_{f1} = \Big(\frac{m_1 - m_2}{m_1 + m_2}\Big)v_{i1} \quad v_{f2} = \Big(\frac{2m_1}{m_1 + m_2}\Big)v_{i1} \tag{22}$$

$$\tau = rF\sin\phi \quad I = \Sigma_j m_j r_j^2 \quad \sum \vec{\tau} = I\vec{\alpha} \tag{23}$$

$$K_{\text{rot}} = \frac{1}{2}I\omega^2 \quad I_{cm}^{\text{rod}} = \frac{1}{12}ML^2 \quad I_{cm}^{\text{disk}} = \frac{1}{2}MR^2 \tag{24}$$

$$I_{cm}^{\text{ring}} = MR^2 \quad I_{cm}^{\text{sphere}} = \frac{2}{5}MR^2 \quad I_{cm}^{\text{hollowsphere}} = \frac{2}{3}MR^2 \tag{25}$$

$$I = I_{cm} + MD^2 \quad W_{\text{rot}} = \tau\theta \tag{26}$$

$$M = \int dm \quad \vec{r}_{\text{cm}} = \frac{1}{M}\int \vec{r}dm \quad I = \int r^2 dm \tag{27}$$

Math relations and constants

$$\cos\theta = x/h \quad \sin\theta = y/h \quad \tan\theta = y/x \tag{28}$$

$$|\vec{r}| = \sqrt{x^2 + y^2 + z^2} \tag{29}$$

$$\lambda = M/L \quad \sigma = M/A \quad \rho = M/V \tag{30}$$

$$az^2 + bz + c = 0 \quad z = \frac{-b}{2a} \pm \frac{\sqrt{b^2 - 4ac}}{2a} \tag{31}$$

$$\int t^n dt = t^{n+1}/(n+1) \quad (\text{if } n \neq -1) \qquad \int t^{-1} dt = \ln t \tag{32}$$

$$\vec{A} \cdot \vec{B} = AB\cos\phi = A_x B_x + A_y B_y + A_z B_z \tag{33}$$

$$\text{Circumference} = 2\pi r \quad A = \pi r^2 \quad V = \frac{4}{3}\pi r^3 \tag{34}$$

$$g = 9.8 \text{ m/s}^2 = 32.2 \text{ ft/s}^2 \quad G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2 \tag{35}$$

$$c = 2.998 \times 10^8 \text{ m/s} \quad m_e = 9.109 \times 10^{-31} \text{ kg} \quad m_p = 6.726 \times 10^{-27} \text{ kg} \tag{36}$$

$$M_{\text{Sun}} = 1.99 \times 10^{30} \text{ kg} \quad M_{\text{Earth}} = 5.98 \times 10^{24} \text{ kg} \tag{37}$$