

# PHYS 1211 Fall 2019 Final Exam

## Equation Sheet

### Test 1 equations

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

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

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

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

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

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

$$\omega = 2\pi/T \quad s = r\theta \quad T = \frac{2\pi r}{v} \quad a_r = \frac{v_t^2}{r} \quad (7)$$

$$\omega_{\text{avg}} = \frac{\Delta\theta}{\Delta t} \quad \alpha_{\text{avg}} = \frac{\Delta\omega}{\Delta t} \quad \omega = \frac{d\theta}{dt} \quad \alpha = \frac{d\omega}{dt} \quad (8)$$

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

$$\omega_f = \omega_i + \alpha(t_f - t_i) \quad \omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i) \quad (10)$$

$$v_t = r\omega \quad a_t = r\alpha \quad (11)$$

### Test 2 equations

$$\sum \vec{F} = m\vec{a} \quad \vec{F}_g = -mg\hat{j} \quad (12)$$

$$f_s^{\text{max}} = \mu_s N \quad f_k = \mu_k N \quad F_{\text{spring}} = -kx \quad (13)$$

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

$$\vec{v}' = \vec{v} - \vec{v}_o \quad \vec{r}' = \vec{r} - \vec{v}_o t \quad K = \frac{1}{2}mv^2 \quad (15)$$

$$W = \vec{F} \cdot \vec{s} \quad W = \Delta K \quad W = \int \vec{F} \cdot d\vec{r} \quad (16)$$

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

### Test 3 equations

$$E_f = E_i + W_{\text{NC}} \quad E = K + U \quad W_C = -\Delta U \quad (18)$$

$$F_r = -\frac{dU}{dr} \quad U_G = -\frac{Gm_1m_2}{r} \quad U_g = mgy \quad U_s = \frac{1}{2}kx^2 \quad (19)$$

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

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

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

$$\tau = rF \sin \phi \quad I = \sum_j m_j r_j^2 \quad \sum \vec{\tau} = I\vec{\alpha} \quad (23)$$

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

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

$$I = I_{\text{cm}} + MD^2 \quad W_{\text{rot}} = \tau\theta = \Delta K_{\text{rot}} \quad (26)$$

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

### Post Test 3 equations

$$\vec{\tau} = \vec{r} \times \vec{F} \quad \vec{L} = I\vec{\omega} = \vec{r} \times \vec{p} \quad \frac{d\vec{L}}{dt} = \vec{\tau}_{\text{net}} \quad (28)$$

$$x(t) = A \cos(\omega t + \phi) \quad v(t) = -A\omega \sin(\omega t + \phi) \quad (29)$$

$$a(t) = -A\omega^2 \cos(\omega t + \phi) \quad \frac{d^2 x(t)}{dt^2} + \omega^2 x(t) = 0 \quad (30)$$

$$\omega = 2\pi/T = 2\pi f \quad \omega = \sqrt{k/m} \quad \omega = \sqrt{g/L} \quad (31)$$

$$v = f\lambda \quad \omega = 2\pi f \quad f = \frac{1}{T} \quad v_{\text{sound}} = \left(\frac{\gamma k_B T}{m}\right)^{1/2} \quad (32)$$

$$y(x, t) = A \sin(kx \mp \omega t + \phi_0) \quad k = 2\pi/\lambda \quad (33)$$

$$f_o = f_s \left( \frac{1 \pm v_0/v}{1 \mp v_s/v} \right) \quad n = c/v \quad \omega = \sqrt{MgL/I} \quad (34)$$

### Math relations and constants

$$\cos \theta = x/h \quad \sin \theta = y/h \quad \tan \theta = y/x \quad (35)$$

$$|\vec{r}| = \sqrt{x^2 + y^2 + z^2} \quad (36)$$

$$\lambda = M/L \quad \sigma = M/A \quad \rho = M/V \quad (37)$$

$$az^2 + bz + c = 0 \quad z = \frac{-b}{2a} \pm \frac{\sqrt{b^2 - 4ac}}{2a} \quad (38)$$

$$\int t^n dt = t^{n+1}/(n+1) \quad (\text{if } n \neq -1) \quad \int t^{-1} dt = \ln t \quad (39)$$

$$\vec{A} \cdot \vec{B} = AB \cos \phi = A_x B_x + A_y B_y + A_z B_z \quad (40)$$

$$\vec{A} \times \vec{B} = AB \sin \phi = \langle (A_y B_z - A_z B_y), -(A_x B_z - A_z B_x), (A_x B_y - A_y B_x) \rangle \quad (41)$$

$$\text{Circumference} = 2\pi r \quad A = \pi r^2 \quad V = \frac{4}{3}\pi r^3 \quad (42)$$

$$g = 9.8 \text{ m/s}^2 = 32.2 \text{ ft/s}^2 \quad G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2 \quad (43)$$

$$c = 2.998 \times 10^8 \text{ m/s} \quad m_e = 9.109 \times 10^{-31} \text{ kg} \quad m_p = 1.6726 \times 10^{-27} \text{ kg} \quad (44)$$

$$M_{\text{Sun}} = 1.99 \times 10^{30} \text{ kg} \quad M_{\text{Earth}} = 5.98 \times 10^{24} \text{ kg} \quad k_B = 1.38 \times 10^{-23} \text{ J/K} \quad (45)$$