

PHYS 1311 Spring 2022 Test 3

Test 1 equations

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

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

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

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

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

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

$$\vec{p}_f = \vec{p}_i + \vec{F}_{\text{net}}\Delta t \quad \vec{p} \approx m\vec{v} \quad \vec{p} = \gamma m\vec{v} \quad (7)$$

$$\gamma = \frac{1}{\sqrt{1 - (|\vec{v}|/c)^2}} \quad \vec{r}' = \vec{r} - \vec{v}_0 t \quad \vec{v}' = \vec{v} - \vec{v}_0 \quad (8)$$

$$\sum_j \vec{F}_j = \vec{F}_{\text{net}} = m\vec{a} \quad \vec{J} = \vec{F}_{\text{net}}\Delta t \quad |\vec{F}_{\text{grav}}| = mg \quad (9)$$

$$|\vec{F}_{\text{spring}}| = k_s|s| \quad s = |\vec{L}| - L_0 \quad (10)$$

Test 2 equations

$$\vec{F}_e = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{|\vec{r}|^2} \hat{r} \quad \vec{F}_{\text{grav}} = -G \frac{m_1 m_2}{|\vec{r}|^2} \hat{r} \quad (11)$$

$$|\vec{f}_s^{\text{max}}| = \mu_s |\vec{F}_N| \quad |\vec{f}_k| = \mu_k |\vec{F}_N| \quad (12)$$

$$\vec{r}_{\text{cm}} = \frac{m_1 \vec{r}_1 + m_2 \vec{r}_2}{m_1 + m_2} \quad \vec{v}_{\text{cm}} = \frac{m_1 \vec{v}_1 + m_2 \vec{v}_2}{m_1 + m_2} \quad (13)$$

$$x(t) = A \cos(\omega t + \phi_0) \quad \frac{d^2 x(t)}{dt^2} + \omega^2 x(t) = 0 \quad (14)$$

$$\omega = 2\pi/T = 2\pi f \quad \omega = \sqrt{k/m} \quad \omega = \sqrt{g/L} \quad s = r\theta \quad (15)$$

Test 3 equations

$$T = \frac{2\pi r}{v} \quad a_r = \frac{v_t^2}{r} \quad T = \frac{2\pi r^{3/2}}{\sqrt{GM}} \quad v = \sqrt{\frac{GM}{r}} \quad (16)$$

$$\omega_{\text{avg}} = \frac{\Delta\theta}{\Delta t} \quad \alpha_{\text{avg}} = \frac{\Delta\omega}{\Delta t} \quad \omega = \frac{d\theta}{dt} \quad \alpha = \frac{d\omega}{dt} \quad (17)$$

$$\theta_f = \theta_i + \frac{1}{2}(\omega_i + \omega_f)(t_f - t_i) \quad \theta_f = \theta_i + \omega_i(t_f - t_i) + \frac{1}{2}\alpha(t_f - t_i)^2 \quad (18)$$

$$\omega_f = \omega_i + \alpha(t_f - t_i) \quad \omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i) \quad (19)$$

$$v_t = r\omega \quad a_t = r\alpha \quad \vec{F}_{\parallel} = (\vec{F} \cdot \hat{p})\hat{p} = F \cos \theta \hat{p} \quad (20)$$

$$K = \frac{1}{2}mv^2 = \frac{p^2}{2m} \quad W = \vec{F} \cdot \vec{s} \quad W = \Delta K \quad (21)$$

$$E_{\text{particle}} = \gamma mc^2 = E_{\text{rest}} + K \quad E_{\text{rest}} = mc^2 \quad K = (\gamma - 1)E_{\text{rest}} \quad (22)$$

$$E^2 - (pc)^2 = (mc^2)^2 \quad E_f = E_i + W_{\text{surr}} \quad (23)$$

$$W = \int \vec{F} \cdot d\vec{r} \quad W_C = -\Delta U \quad (24)$$

$$F_r = -\frac{dU}{dr} \quad U_g = -\frac{Gm_1m_1}{r} \quad U_g = mgy \quad U_e = \frac{k_e q_1 q_2}{r} \quad (25)$$

$$U_s = \frac{1}{2}kx^2 \quad E = \sum_j^N [m_j c^2 + K_j] + \sum_{j \neq k} U_{jk} \quad (26)$$

Math relations and constants

$$\cos \theta = x/h \quad \sin \theta = y/h \quad \tan \theta = y/x \quad (27)$$

$$\vec{r} = |\vec{r}|\hat{r} \quad |\vec{r}| = \sqrt{x^2 + y^2 + z^2} \quad (28)$$

$$az^2 + bz + c = 0 \quad z = \frac{-b}{2a} \pm \frac{\sqrt{b^2 - 4ac}}{2a} \quad (29)$$

$$\vec{A} \cdot \vec{B} = AB \cos \phi = A_x B_x + A_y B_y + A_z B_z \quad (30)$$

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \dots \quad \cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \dots \quad (31)$$

$$\frac{d}{dx} \left[\frac{u}{v} \right] = \frac{1}{v} \frac{du}{dx} - \frac{u}{v^2} \frac{dv}{dx} \quad \text{Circumference} = 2\pi r \quad (32)$$

$$(1 \pm \epsilon)^{-n} = 1 \mp n\epsilon + \frac{n(n+1)\epsilon^2}{2!} \mp \dots, \epsilon \ll 1 \quad (33)$$

$$A = \pi r^2 \quad V = \frac{4}{3}\pi r^3 \quad g = 9.8 \text{ m/s}^2 \quad G = 6.673 \times 10^{-11} \text{ Nm}^2/\text{kg}^2 \quad (34)$$

$$c = 2.998 \times 10^8 \text{ m/s} \quad m_e = 9.109 \times 10^{-31} \text{ kg} \quad m_p = 1.6726 \times 10^{-27} \text{ kg} \quad (35)$$

$$M_{\text{Earth}} = 5.97 \times 10^{24} \text{ kg} \quad 1e = 1.6 \times 10^{-19} \text{ C} \quad k_e = 9 \times 10^9 \text{ Nm}^2/\text{C}^2 \quad (36)$$