

Physics 1210
Spring 2016
 Prof. Jang-Condell

Equation Sheet For Exam #3

Kinematics $v_{\text{avg}} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{\Delta x}{\Delta t}$ $\vec{v} = \frac{d\vec{r}}{dt}$ $a_{\text{avg}} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$ $\vec{a} = \frac{d\vec{v}}{dt}$ $g = 9.80 \text{ m/s}^2$

$x_1 = x_0 + v_0 t + \frac{1}{2} a t^2$ $v_1 = v_0 + a t$ $v_1^2 = v_0^2 + 2a(x_1 - x_0)$ $a_{\text{rad}} = \frac{v^2}{R} = \frac{4\pi^2 R}{T^2}$

$\sum \vec{F} = m\vec{a}$ $\vec{w} = m\vec{g}$ $f_s \leq \mu_s N$ $f_k = \mu_k N$ $f = kv$ $f = Dv^2$ $f_{\text{spring}} = -kx$

Momentum/Impulse $\vec{p} = m\vec{v}$ $J = \Delta(mv) = F\Delta t$ $x_{\text{cm}} = \frac{\sum m_i x_i}{\sum m_i}$

Work/Energy $W = \vec{F} \cdot \vec{s} = F s \cos \theta$ $K_1 + U_1 + W_{\text{other}} = K_2 + U_2$ $P = \frac{\Delta W}{\Delta t} = \vec{F} \cdot \vec{v}$

$W = \Delta K$ $K = \frac{1}{2} m v^2$ $U_{\text{spring}} = \frac{1}{2} k x^2$ $U_{\text{grav}} = mgy$ $F = -\frac{dU}{dx}$

Angular Motion $\theta_1 = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$ $\omega_1 = \omega_0 + \alpha t$ $\omega_1^2 = \omega_0^2 + 2\alpha(\theta_1 - \theta_0)$

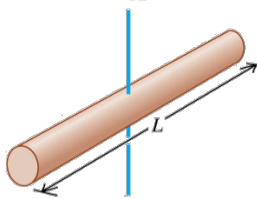
$\omega = \frac{d\theta}{dt}$ $\alpha = \frac{d\omega}{dt}$ $s = r\theta$ $v = r\omega$ $a_{\text{tan}} = r\alpha$ $a_{\text{rad}} = \omega^2 r$ $2\pi = 360^\circ$

$I = \sum_i m_i r_i^2$ $I = I_{\text{cm}} + M d^2$ $\vec{\tau} = \vec{r} \times \vec{F} = r F \sin \phi$ $\sum \vec{\tau} = I \vec{\alpha}$ $W = \Delta K = \tau \Delta \theta$

$K_{\text{rot}} = \frac{1}{2} I \omega^2$ $K_{\text{tot}} = \frac{1}{2} m v_{\text{cm}}^2 + \frac{1}{2} I_{\text{cm}} \omega^2$ $\vec{L} = \vec{r} \times \vec{p} = r m v = I \omega$ $\Delta L = \tau \Delta t$ $\text{power} = \tau \omega$

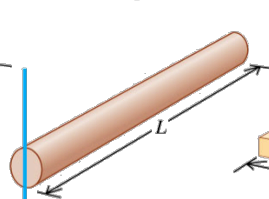
(a) Slender rod, axis through center

$I = \frac{1}{12} M L^2$



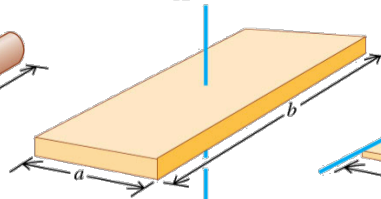
(b) Slender rod, axis through one end

$I = \frac{1}{3} M L^2$



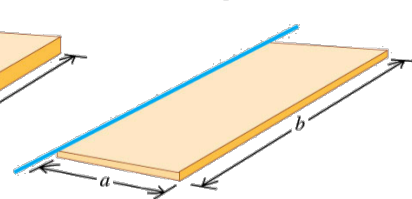
(c) Rectangular plate, axis through center

$I = \frac{1}{12} M (a^2 + b^2)$



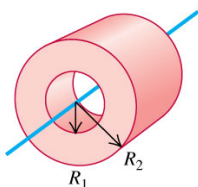
(d) Thin rectangular plate, axis along edge

$I = \frac{1}{3} M a^2$



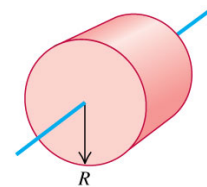
(e) Hollow cylinder

$I = \frac{1}{2} M (R_1^2 + R_2^2)$



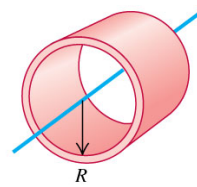
(f) Solid cylinder

$I = \frac{1}{2} M R^2$



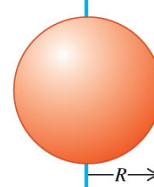
(g) Thin-walled hollow cylinder

$I = M R^2$



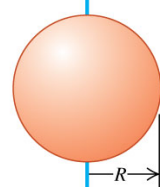
(h) Solid sphere

$I = \frac{2}{5} M R^2$



(i) Thin-walled hollow sphere

$I = \frac{2}{3} M R^2$



Fluids $p = \frac{dF_{\perp}}{dA}$ $p_2 - p_1 = -\rho g(y_2 - y_1)$ $p_1 + \rho g y_1 + \frac{1}{2} \rho v_1^2 = p_2 + \rho g y_2 + \frac{1}{2} \rho v_2^2$
 $\rho_1 A_1 v_1 = \rho_2 A_2 v_2$

Gravity $G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$

$$F_g = \frac{GM_1 M_2}{r^2} \quad U_g = \frac{-GM_1 M_2}{r} \quad v = \sqrt{\frac{Gm_1}{r}} \quad T = \frac{2\pi r}{v} = 2\pi \sqrt{\frac{r^3}{Gm_1}} \quad v_{\text{esc}} = \sqrt{\frac{2Gm_1}{r}}$$

Periodic Motion $f = 1/T$ $\omega = 2\pi f$ $x = A \cos(\omega t + \phi)$ $E = \frac{1}{2} m v^2 + \frac{1}{2} k x^2 = \frac{1}{2} k A^2$

Spring $\omega = \sqrt{\frac{k}{m}}$ Simple pendulum $\omega = \sqrt{\frac{g}{L}}$ Physical pendulum $\omega = \sqrt{\frac{mgd}{I}}$ Damped oscillations $x = A e^{-(b/2m)t} \cos(\omega' t + \phi); \omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$

Mechanical Waves

Waves on a string $v = \sqrt{\frac{F}{\mu}}$ $v = \lambda f$ $y(x, t) = A \cos(kx - \omega t)$ $k = \frac{2\pi}{\lambda}$ $v = \frac{\omega}{k}$
 $f_1 = \frac{v}{2L}$ $f_n = n f_1, (n = 1, 2, 3, \dots)$ $P_{\text{av}} = \frac{1}{2} \sqrt{\mu F} \omega^2 A^2$

Sound

$$v = \sqrt{B/\rho} \quad p_{\text{max}} = BkA \quad I = \frac{P}{4\pi r^2} \quad \frac{I_1}{I_2} = \frac{r_2^2}{r_1^2} \quad I = \frac{P_{\text{max}}^2}{2\rho v} = \frac{P_{\text{max}}^2}{2\sqrt{\rho B}} \quad \beta = (10 \text{ dB}) \log \frac{I}{I_0}$$

Open pipe $f_n = \frac{nv}{2L}, (n = 1, 2, 3, \dots)$ Closed pipe $f_n = \frac{nv}{4L}, (n = 1, 3, 5, \dots)$ $f_{\text{beat}} = f_a - f_b$ $f_L = \frac{v + v_L}{v + v_S} f_S$