Physics 131 Final Exam Equation Sheet

Kinematics

1-D

$v = dx/dt$ $\quad a = dv/dt$

$x_f = x_i + \int_{t_i}^{t_f} v(t)\,dt$ $\quad v_f = v_i + \int_{t_i}^{t_f} a(t)\,dt$

$v_{ave} = \Delta x/\Delta t$ $\quad a_{ave} = \Delta v/\Delta t$

$v_f = v_i + a\,t$

$x_f = x_i + v_i\,t + \frac{1}{2}a\,t^2$

$v_f^2 = v_i^2 + 2a\,(x_f - x_i)$

$\Delta x = \frac{1}{2}(v_i + v_f)\,\Delta t$

Single axis rotation

$\omega = d\theta/dt$ $\quad \alpha = d\omega/dt$

$\theta_f = \theta_i + \int_{t_i}^{t_f} \omega(t)\,dt$ $\quad \omega_f = \omega_i + \int_{t_i}^{t_f} \alpha(t)\,dt$

$\omega_{ave} = \Delta\theta/\Delta t$ $\quad \alpha_{ave} = \Delta\omega/\Delta t$

$\omega_f = \omega_i + \alpha\,t$

$\theta_f = \theta_i + \omega_i\,t + \frac{1}{2}\alpha\,t^2$

$\omega_f^2 = \omega_i^2 + 2\alpha\,(\theta_f - \theta_i)$

$\Delta\theta = \frac{1}{2}(\omega_i + \omega_f)\,\Delta t$

$a_r = -v^2/r$

$a_t = r\alpha$

$v = r\omega$

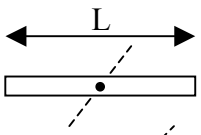
$s = r\theta$

Dynamics

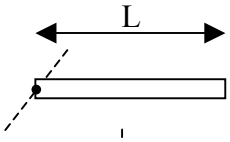
$\vec{F} = m\,\vec{a}$ $\quad \vec{F}_{12} = -\vec{F}_{21}$ $\quad \tau = I\,\alpha$ $\quad \tau = rF\sin\phi$

$x_{cm} = \frac{1}{M}\sum_i m_i x_i$ $\quad I = \sum_i m_i r_i^2$ $\quad I = I_{cm} + Md^2$

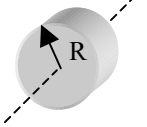
$I = (1/12)\,ML^2$ Rod about center.



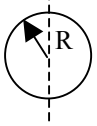
$I = (1/3)\,ML^2$ Rod about end.



$I = (1/2)\,MR^2$ Disk about center.



$I = (2/5)\,MR^2$ Sphere about diameter.



Momentum and Angular Momentum

$\vec{p} = m\vec{v}$ $\quad \vec{F} = \frac{d\vec{p}}{dt}$ $\quad \Delta\vec{p} = J_{ext}$ $\quad J = \int_{t_i}^{t_f} F\,dt = F_{ave}\Delta t$

$L = I\omega$ $\quad L_{particle} = rp = rmv$ $\quad \tau = dL/dt$

Energy and Power

$E_{mech} = K + U$ $\quad \Delta E_{mech} = W_{ext} + W_{int\_friction}$

$K = \frac{1}{2}\,mv^2$ $\quad K_{rot} = \frac{1}{2}\,I\,\omega^2$ $\quad K_{rolling} = \frac{1}{2}\,mv_{cm}^2 + \frac{1}{2}\,I_{cm}\omega^2$

$\Delta U_F = -W_F$ $\quad \Delta U_G = mgy_f - mgy_i$ $\quad \Delta U_{sp} = \frac{1}{2}\,k\,x_f^2 - \frac{1}{2}\,k\,x_i^2$

$W = \int_{x_i}^{x_f} F_x\,dx$ $\quad W = \vec{F} \bullet \Delta\vec{r}$

$P = dW/dt$ $\quad P = \vec{F} \bullet \vec{v}$

Particular Forces

$W = mg$ $\quad F = G\frac{m_1 m_2}{r^2}$ $\quad f_{s\,max} = \mu_s N$ $\quad f_k = \mu_k N$ $\quad F_{sp} = -k\,\Delta x$

Constants

$g = 9.80\ m/s^2$ $\quad G = 6.67 \times 10^{-11}\ N\,m^2/kg^2$