Exam 3, Physics 2008, fall 2008

1. a) $mgy_i = mgy_f + \frac{1}{2}mv^2 \rightarrow y_f = 5\ m$ ($y_i \rightarrow 45\ m$, $v \rightarrow 28\ m/s$)

b) only gravitational force does work, and since that's a conservative force, the mechanical energy is path independent

c) $mgy_i = \frac{1}{2}kx^2 \rightarrow k = 2300\ N/m$ (minimum k needed)

d) $mgy_i = mgy_f + \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$; $I = \frac{2}{5}mr^2$, $\omega = \frac{v}{r}$

$\rightarrow mg(y_i - y_f) = \frac{7}{10}mv^2 \rightarrow v = 24\ m/s$ (slower)

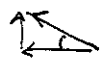
2. a) $m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$

($300\ m/s \downarrow$, $-5\ m/s \rightarrow$, $250\ m/s \rightarrow$) $\rightarrow \vec{v}_{2f} = -4.65\ m/s$

b) $K_i = 233938\ J$, $K_f = 163980\ J \rightarrow \Delta K = -7.00 \times 10^4\ J$

mostly to deformation of box; some sound, thermal energy

c) $\vec{p}_i = m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = 2.88\hat{j} - 4.50\hat{i}\ kg\ m/s$



so $(m_1+m_2)v_{fx} = -4.50 \rightarrow v_{fx} = -2.045\ m/s$

$(m_1+m_2)v_{fy} = 2.88 \rightarrow v_{fy} = 1.309\ m/s$

} or $2.43\ m/s$ at $32.6°$ N of W

(ring, rockets)

3. a) $I = MR^2 + 2mr^2 = 1.02 \times 10^{11}\ kg \cdot m^2$

b) $\omega = v/R = 0.073\ rad/s$

c) $0.073\ rad/s = 0.70\ rev/min$

d) yes - ω same for rotating rigid body at any r

e) const rotation $\rightarrow a = a_c = \frac{v^2}{R} = 4.0\ m/s^2$ toward center

f) $\omega_f = \omega_i + \alpha t \rightarrow t = \frac{\Delta\omega}{\alpha}$

and $\Sigma\tau = I\alpha \rightarrow \alpha = \frac{\Sigma\tau}{I} = \frac{2(Fr)}{I} = 0.00029\ rad/s^2$

so $t = 248\ s$

4 a) $F_{avg} = \frac{I}{\Delta t} = \frac{\Delta p}{\Delta t} = 200\ N$

b) since $mV = Mv$ and $K = \frac{1}{2}mv^2$, $\frac{1}{2}mV^2 > \frac{1}{2}Mv^2 \rightarrow$ ink has larger K

c) if same m, same mechanical energy $\rightarrow$ same v at ground level

d) C ($\vec{F}_{12} = -\vec{F}_{21}$ for interacting objects)

e) $x_{cm} = \frac{\Sigma mx}{\Sigma m} = \frac{0+1+2(2)}{4} = \frac{5}{4}\ m$; $y_{cm} = \frac{2(1)+2+3}{4} = \frac{7}{4}\ m$

f) constant v $\rightarrow F = mg$ & $P = Fv = 59\ W$

g) solid wheels have smaller I $\rightarrow$ greater α for same $\tau \rightarrow$ solid faster

h) $\overleftarrow{F}$ yes, torque $\neq 0$; $\downarrow$ no, torque $= 0$ ($\phi = 0°$)

extra credit: momentum