PHY 131 – Review for Exam 2:

(1) $\tau = I\alpha$ $\qquad I = \frac{2}{5}MR^2$ for a solid sphere

$= \frac{2}{5}(3\,\text{kg})(.35\,\text{m})^2 = .147\ \text{kg}\cdot\text{m}^2$

$7.5 = (.147)\,\alpha$

$\alpha = \frac{7.5}{.147} = 51.0\ \frac{\text{RAD}}{\text{s}^2}$

also given: $t = 7.0\,\text{s}$, $\omega_i = 0$ $\qquad$ Find: $\Delta\theta$

$\Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2 = 0 + \frac{1}{2}(51\ \frac{\text{RAD}}{\text{s}^2})(7\,\text{s})^2 = \boxed{1250\ \text{RAD}}$ ANS

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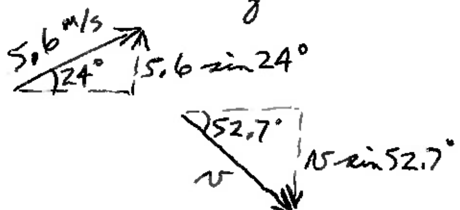
(2) This can be done using either x components or y components. I'll write it out both ways; you only need to solve the problem once:

Conservation of momentum: (P_Y) before $= (P_Y)$ after



$0 = (2\,\text{kg})(5.6 \sin 24°) + (3\,\text{kg})(-v \sin 52.7°)$ DOWN

$0 = 4.555 - 2.386\,v$

$2.386\,v = 4.555 \Rightarrow v = \boxed{1.91\ \text{m/s}}$ ANS

OR (ALTERNATE SOLUTION):

Conservation of momentum: (P_X) before $= (P_X)$ after

$(2\,\text{kg})(9.1\,\text{m/s}) + (3\,\text{kg})(-1.5\,\text{m/s}) = (2)(5.6 \cos 24°) + (3)(v \cos 52.7°)$

$18.2 - 4.5 = 10.23 + 1.818\,v$

$3.47 = 1.818\,v \Rightarrow v = \frac{3.47}{1.818} = \boxed{1.91\ \text{m/s}}$ ANS

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(3) $E_i + W = E_f$

$(KE + U)_i + \underbrace{(-Fs)}_{\substack{W = F\cos\theta\, s \\ \theta = 180°}} = (KE + U)_f$

$v_i = 0 \qquad v_f = 0 \qquad h_f = 0$

$mgh_i - Fs = 0$

$mgh_i = Fs \Rightarrow F = \frac{mgh_i}{s} = \frac{(230\,\text{kg})(9.8\,\text{m/s}^2)(4.7\,\text{m})}{.13\,\text{m}} = \boxed{8.15 \times 10^4\ \text{N}}$ ANS

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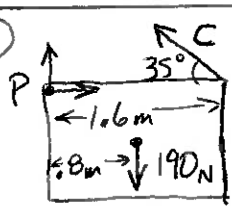
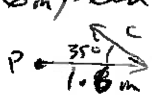
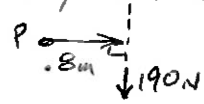
(4)



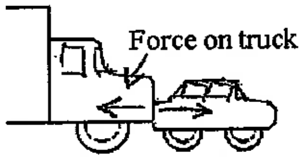
$\Sigma \tau_P = 0$ $\qquad$ where $\tau = r \sin\theta\, F$

$(1.6\,\text{m}) \sin 35° (C) - (.8\,\text{m}) \sin 90° (190\,\text{N}) = 0$





$.9177\,C - 152 = 0 \Rightarrow C = \frac{152}{.9177} = \boxed{166\ \text{N}}$ ANS

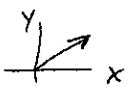
5. a. i. Back: 

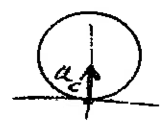
ii. Same size. By Newton's third law, action and reaction have equal magnitudes. (And opposite directions.)

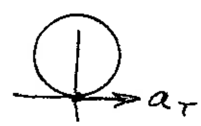
b. Same. Identical forces act through the same distance so the same work is done. $W = \Delta KE$.

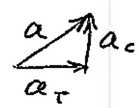
c. Puck b. Due to its greater inertia, it takes more time to reach line 2. Since the same force acts through a greater time, there is a greater impulse. $I = \Delta p$.

d. $-\hat{j}$. A cross product is perpendicular to both vectors being multiplied, so the product of something in the x and z directions must be in either the + or – y directions. The right hand rule is for choosing between these two alternatives. Wrap your fingers around the y axis with your fingers pointing from the first vector toward the second one. Your thumb points in the direction of the cross product.

e. 

There is a centripetal component due to the circular motion: 

There is also a tangential component due to the increasing speed: 

The total acceleration is the resultant of its two components: 

PHY 131
REVIEW OF 5-8

SOLUTIONS

(1) a) DISK: $I = \frac{1}{2}MR^2 = \frac{1}{2}(2.5\,kg)(.15\,m)^2 = \boxed{.0281\ kg\cdot m^2}$

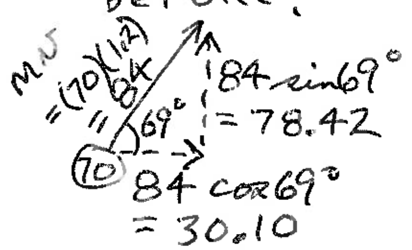
b) $\tau = I\alpha$ REQUIRES RADIANS

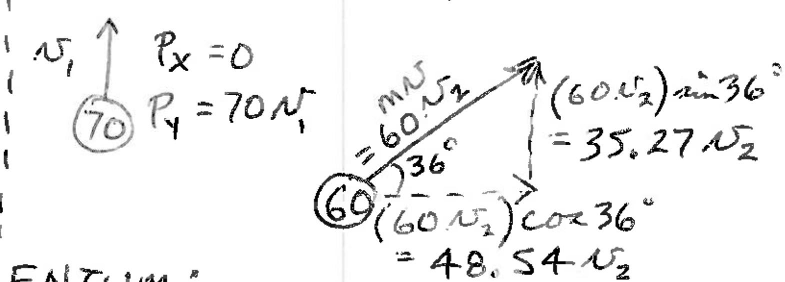
$$\omega_f = \left(480\,\frac{\cancel{REV}}{\cancel{MIN}}\right)\left(\frac{2\pi\,RAD}{1\,\cancel{REV}}\right)\left(\frac{1\,\cancel{MIN}}{60\,s}\right) = 50.27\ \frac{RAD}{s}$$

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{50.27 - 0}{5\ SEC} = 10.05\ \frac{RAD}{s^2}$$

$$\tau = I\alpha = (.0281)(10.05) = \boxed{.282\ N\cdot m}$$

(2) BEFORE: AFTER:





CONSERVATION OF X MOMENTUM:

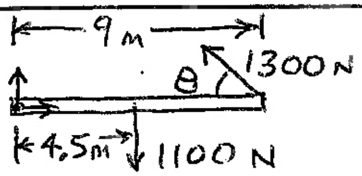
$$30.10 + 0 = 0 + 48.54v_2 \Rightarrow v_2 = \frac{30.1}{48.54} = \boxed{.620\ m/s}$$

Y MOMENTUM:

$$78.42 + 0 = 70v_1 + 35.27(.620)$$

$$78.42 = 70v_1 + 21.87 \Rightarrow 56.55 = 70v_1 \Rightarrow v_1 = \frac{56.55}{70} = \boxed{.808\ m/s}$$

(3)



$\Sigma\tau = 0$ WHERE $\tau = r\sin\theta F$

$$(9m)\sin\theta(1300N) - (4.5m)\sin 90°(1100N) = 0$$

$$11700\sin\theta = 4950$$

$$\sin\theta = \frac{4950}{11700} = .4231 \Rightarrow \theta = \boxed{25.0°}$$

(4) G = GLIDER; H = HANGING

$$(E_G + E_H)_o = (E_G + E_H)_f \quad \text{(conservation of energy)}$$

$$0 + (.17\,kg)(9.8\,m/s^2)(1.4\,m) = \frac{1}{2}(.3\,kg)v^2 + \frac{1}{2}(.17\,kg)v^2$$

same v because tied together.

(initial $U_g = mgh$ of the hanging .17 kg winds up as $KE = \frac{1}{2}mv^2$ shared by both.)

$$2.3324 = .15v^2 + .085v^2$$

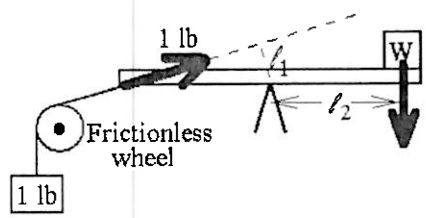
$$v = \sqrt{\frac{2.3324}{.15 + .085}} = \sqrt{9.925} = \boxed{3.15\ m/s}$$

5. a. Thermal energy. (Heat.) As the jello is being deformed during the collision with the floor, there is internal friction which raises the temperature somewhat.

b. +y. A torque vector is along the axis of rotation, pointing in a right-handed direction. Imagine wrapping your fingers around a line through the hinges, with the tips of your fingers pointing in the direction you are pulling the door. Your thumb points up.

c. Same. By conservation of momentum, the momentum gained by the bullet in one direction equals the momentum gained by the gun in the other. Since the bullets get the same momentum (same m and v), so do the guns.

d. Less. One pound times a smaller moment arm equals less force times a larger moment arm.



e. i. Same. To contact each other without slipping (grinding across each other), the teeth must have the same speed.

ii. Less. $\omega = \frac{v}{r}$. The previous answer was that v is the same, so the one with the larger radius has the smaller ω.