Practice Exam 4 Sol^{n}s

1) the moment of inertia of a rectangle about it's center of mass is

$$I = \frac{1}{12}M(a^2+b^2) = \frac{kg}{12}\left(.4^2+.5^2\right)$$

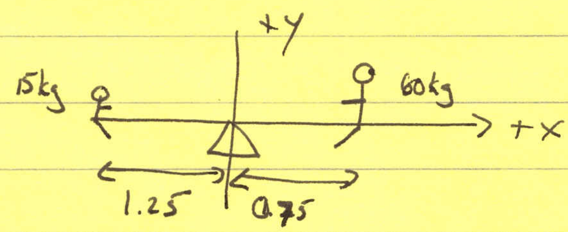
$$= \frac{kg}{12}\left(.16+.25\right)m^2$$

$$= \frac{.41}{12}\ kg\ m^2$$

$$KE = \tfrac{1}{2}I\omega^2 = \frac{41}{2400}\ kg\frac{m^2}{s^2}\ (100)^2$$

$$= \frac{41}{.24}\ J \simeq 171 J$$

3) using the pivot as the center of rotation



a) $\vec{\tau}_B = (1.25m)\, 15kg \times 9.8 m/s^2\ \hat{k}$

$= 183.75\ Nm\ \hat{k}$

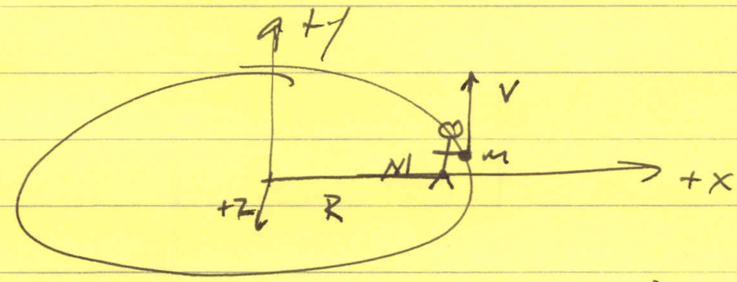
b) $\vec{\tau}_S = (0.75m)(60kg) \times 9.8 m/s^2 (-\hat{k})$

$= -441\ Nm\ \hat{k}$

$$\vec{\alpha} = \frac{\sum \vec{\tau}}{I} = \frac{\vec{\tau}_B + \vec{\tau}_S}{I} = \frac{(184-441)Nm\,\hat{k}}{I} = \frac{-257 Nm\,\hat{k}}{I}$$

so $\vec{\alpha} \neq 0$.

4)



If we define the merry go round + David + Tomato to be our system, there are no external forces (aside from gravity & Normal forces). $\Rightarrow \sum \vec{\tau} = 0$ and $\vec{L}$ is conserved.

$$\vec{L}_i = \vec{L}_f$$

$\because \vec{L}_i = 0$, nothing is moving

$$\vec{L}_f = I_{David}\,\omega + I_{merry}\,\omega + RmV$$
$$= (-MR^2\omega - I\omega + RmV)\,\hat{j}$$
$$(MR^2 + I)\,\omega = RmV$$

a) $$\boxed{\omega = \frac{RmV}{I + MR^2}}$$

to get translational velocity

$$V = \omega R$$

b) $$\boxed{V = \frac{mR^2 V}{I + MR^2}}$$