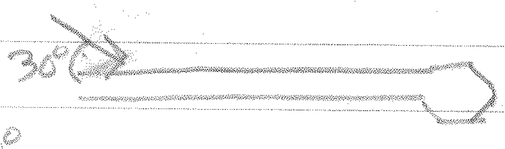
Torque + Rotation Review

1.) $\tau = \vec{F} \cdot d$

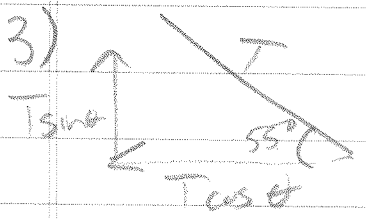
$\hookrightarrow \tau = (250.0N)\cdot(.540m) = 135N$

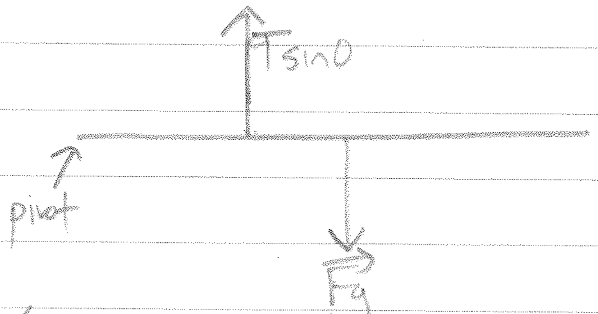
2) $\tau = F_{\perp} \cdot d$



$\tau = F \cdot d \cdot \sin 30^\circ$

3)





$\Sigma\tau = 0\,N\cdot m = (T\sin 55^\circ \cdot 1.6m) = (500N \cdot 2.0m)$

$\hookrightarrow T = \dfrac{500N \cdot 2.0m}{(\sin 55^\circ)\,1.6m} \boxed{= 763N}$

4.) $\tau = I \cdot \alpha = mr^2 \cdot \alpha = (3.1kg)(.28m)^2 \cdot (4.8\,rad/s^2)$

$\tau = 1.2\,N\cdot m$

5.) Hollow cylinder → mass is concentrated towards the outside

-also $I_{\text{hollow cylinder}} = Mr^2$

$I_{\text{solid cylinder}} = \frac{1}{2}mr^2$

6) solid cylinder, smaller I, easier to get rolling

7.) $U_g = K_{rot} + K_{trans}$

$mgh = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2 \rightarrow$ ~~$mgh = \frac{1}{2}(\frac{1}{2}mr^2)\omega^2 + \frac{1}{2}mv^2$~~

a.) $K_{trans} = mgh - \frac{1}{2}I\omega^2$

b.) $K_{rot} = mgh - \frac{1}{2}mv^2$

c.) ~~Since "I" would decrease, the cylinder is easier to rotate.~~

8.) Sphere 1 $\Rightarrow I = \frac{2}{5}mr^2 = \frac{2}{5}(1.1kg)(.18m)^2 = .0143 kg\cdot m^2$

Sphere 2 $\rightarrow I = \frac{2}{5}mr^2 = \frac{2}{5}(1.8kg)(.14m)^2 = .0141 kg\cdot m^2$

→ Sphere 2 has a lower I, so it is easier to get rotating. Therefore sphere 2 will reach bottom first (but not by much)

9.) By extending her arms outward, she increases her radius, which cause "I" to increase. Since angular momentum must be conserved, increasing "I" causes "w" to decrease.

10.) $V = r\omega \rightarrow = (.11m)(4.8 rad/s) = .528 m/s$

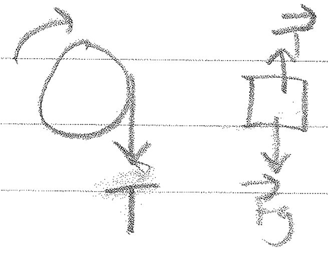
$K_{tot} = K_{rot} + K_{trans} = \frac{1}{2}(mr^2)(\omega)^2 + \frac{1}{2}mv^2$

$\underset{.5018 J}{\frac{1}{2}(.36kg\cdot(.11m)^2)(4.8 rad/s)^2} + \underset{.05018 J}{\frac{1}{2}(.36kg)(.528 m/s)^2} = .1004 J$

11) a.) U_g

b.) it transforms in K_{trans} for box & K_{rot} for pulley

c.)



d.) radius of pulley, mass of pulley, and the final angular speed.

12) $L_i = L_F$

$$I W_i = 2 I W_F$$

$$\hookrightarrow \boxed{W_F = \tfrac{1}{2} W_i}$$

13) $I_{student} = mr^2$

$I_{\substack{merry\\go\\round}} = \frac{1}{2}mr^2$

$$L_i = L_F \rightarrow I_{tot} W_i = I_{tot} W_F$$

$$\hookrightarrow (I_{student} + I_{mgr}) W_i = (I_{student} + I_{mgr}) W_F$$

$$\hookrightarrow W_F = \frac{(I_{student} + I_{mgr}) W_i}{(I_{student} I_{mgr})}$$

$$\hookrightarrow W_F = \frac{(0 + 840\,kg \cdot m^2)\, 1.8\,rad/s}{(42\,kg \cdot (3.4\,m)^2) + 840\,kg \cdot m^2} = \boxed{1.1\,rad/s}$$