ROTATION REVIEW

1. a. $\omega = 4 \text{ RAD/s}$

$$4 \frac{\text{RAD}}{\text{s}} \left| \frac{1 \text{ REV}}{2\pi \text{ RAD}} \right| = \boxed{0.64 \frac{\text{REV}}{\text{s}}}$$

b. $V = r\omega$

$V = 0.4\text{m}(4 \text{ RAD/s})$

$\boxed{V = 1.6 \text{ m/s}}$

c. $\omega_0 = 4 \text{ RAD/s}$

$\omega = 12 \text{ RAD/s}$

$\alpha = 2 \text{ RAD/s}^2$

$\theta = ?$

$$\omega^2 = \omega_0^2 + 2\alpha\theta$$

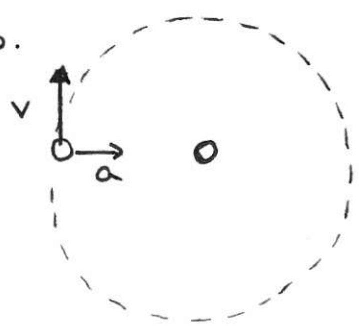
$$\frac{\omega^2 - \omega_0^2}{2\alpha} = \theta$$

$$\frac{12^2 - 4^2}{2(2)} = \theta$$

$$\boxed{32 \text{ RAD} = \theta}$$

2. a. A REVOLUTION IS THE MOVEMENT OF ONE OBJECT AROUND ANOTHER. A FORCE (TENSION, FRICTION, OR GRAVITY FOR EXAMPLE) MUST ACT TO KEEP THE OBJECT ON A CIRCULAR PATH.

b.



c. A ROTATION IS THE MOVEMENT OF AN OBJECT AROUND ITS OWN AXIS. A TORQUE IS NEEDED TO SPIN AN OBJECT ON ITS AXIS.

d. $v = r\omega$ $\quad a = r\alpha$ $\quad x = r\theta$

e. MASS AND THE LOCATION OF THE MASS IN RELATION TO THE PIVOT POINT.

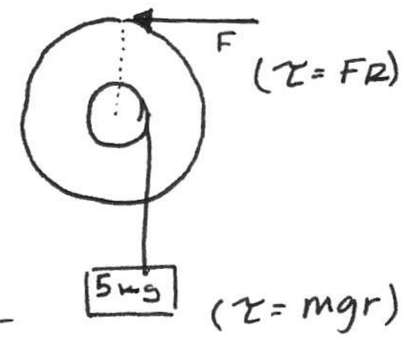
3\. a. $\Sigma\tau = I\alpha = FR - mgr$

EQUILIBRIUM $\rightarrow$ $0 = FR - mgr$

$mgr = FR$

$5kg(10m/s^2)(.2m) = F(0.8m)$

$\boxed{12.5N = F}$



b. $\Sigma\tau = I\alpha = Tr$ $\quad \Sigma F = ma = mg - T$

$I\frac{a}{r} = Tr$ $\quad ma = mg - T$

$5a = 50 - T$

$\frac{I}{r^2} a = T$

$\frac{8}{.2^2} a = T$

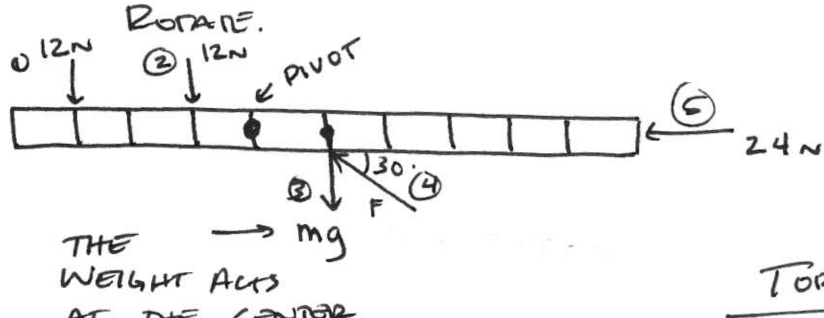
$200a = T$

$$\begin{aligned} 200a &= T \\ 5a &= 50 - T \\ \hline 205a &= 50 \end{aligned}$$

$\boxed{a = 0.244 m/s^2}$

c. MOVING MORE MASS TO THE OUTER EDGE OF THE WHEEL INCREASES THE MOMENT OF INERTIA. A BIGGER I DECREASES THE ACCELERATION OF THE SYSTEM BECAUSE THE SYSTEM IS MORE DIFFICULT TO ROTATE.

3.3.



• EACH SECTION IS 0.1m WIDE

TORQUES

① $\tau = 12N(.3m) = 3.6N\cdot m$ CCW +

② $\tau = 12N(.1m) = 1.2N\cdot m$ CCW +

③ $\tau = mg(.1m) = 2N\cdot m$ CW −

④ $\tau = F\sin 30(.1m) = F(.5)(.1)$ CW −

⑤ $\tau = 0$

a. $\Sigma\tau = 3.6 + 1.2 - 2 - F(.5)(.1)$

$\Sigma\tau = 0$ (EQUILIBRIUM)

$3.6 + 1.2 - 2 - F(.05) = 0$

$2.8 = F(.05)$

$\boxed{56N = F}$

b. $\Sigma\tau = 3.6 + 1.2 - 2$

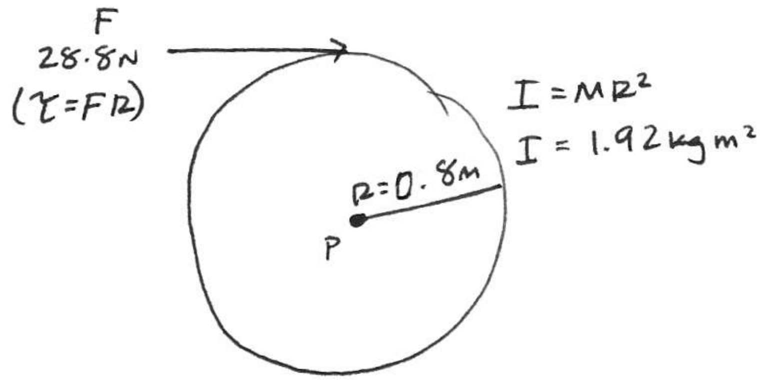
$I\alpha = 2.8$

$\alpha = \frac{2.8}{0.4} = \boxed{7 RAD/s^2}$

4. a. $MR^2 = 1.92\ \text{kg m}^2$

$M = \dfrac{1.92}{(.8)^2}$

$\boxed{M = 3\text{kg}}$



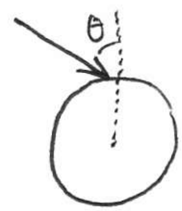
b. $\Sigma\tau = I\alpha$

$FR = I\alpha$

$28.8(.8) = (1.92)\alpha$

$\boxed{12\text{RAD/s}^2 = \alpha}$

c. 1. DECREASE F
2. APPLY F AT AN ANGLE $\Longrightarrow$
3. INCREASE MASS
4. INCREASE RADIUS OF WHEEL



5. $\omega_0 = 4\ \text{RAD/s}$
$\omega = 0$
$t = 2\text{s}$
$\alpha = ?$

$\omega = \omega_0 + \alpha t$

$\dfrac{\omega - \omega_0}{t} = \alpha$

$\dfrac{0-4}{2} = \alpha$

$2\text{RAD/s}^2 = \alpha$

$\tau = I\alpha$

$\tau = I\alpha$

$\tau = 500\ \text{kg m}^2\ (2\text{RAD/s}^2)$

$\boxed{\tau = 1000\ \frac{\text{kg m}^2}{s^2}}$

6. a. YES. NOTHING FROM OUTSIDE OF THE MAN/WEIGHT/PLATFORM/EARTH SYSTEM ACTS ON THE OBJECTS.
- ANGULAR MOMENTUM WILL BE CONSERVED BECAUSE THERE ARE NO OUTSIDE TORQUES.

b. THE MAN WILL SPEED UP → HE DECREASES HIS MOMENT OF INERTIA & INCREASES HIS ANGULAR VELOCITY.
(BY PULLING HIS ARMS IN HE DOES + WORK ON THE SYSTEM).

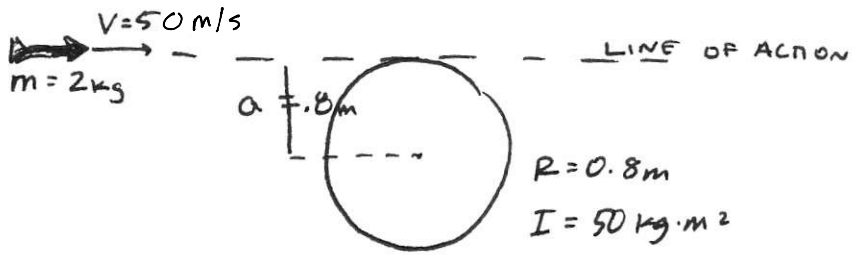
c. $L_i = L_f$

$I_i\omega_i = I_f\omega_f$

$500\left(\frac{6}{\pi}\right) = I_f\left(\frac{8}{\pi}\right)$

$\boxed{375\ \text{kg m}^2 = I_f}$

7.



$L_i = L_F$

$L_D + L_W = L_{D+W}$

$mva + 0 = (I_D + I_W)\,w$

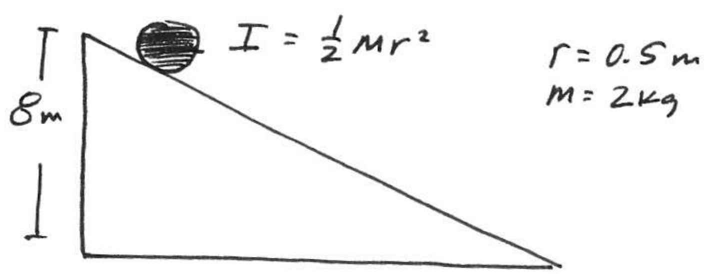
$mva = (mR^2 + 50)\,w$

$2(50)(.8) = (2(.8)^2 + 50)\,w$

$80 = (51.28)\,w$

$\boxed{1.6 \text{ RAD/s} = w}$

8.



a. $E_{TOP} = mgh$

$E_{BOTTOM} = K + K_{ROT}$ ⇒ BECAUSE THE OBJECT ROLLS W/OUT SLIPPING IT WILL HAVE BOTH FORMS OF KINETIC ENERGY

$E_{TOP} = E_{BOTTOM}$

$mgh = \frac{1}{2}mv^2 + \frac{1}{2}Iw^2 \quad \left[I = \frac{1}{2}mR^2,\ w = \frac{V}{R}\right]$

$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{1}{2}m\cancel{R^2}\right)\left(\frac{v^2}{\cancel{R^2}}\right)$

$mgh = \frac{1}{2}mv^2 + \frac{1}{4}mv^2$

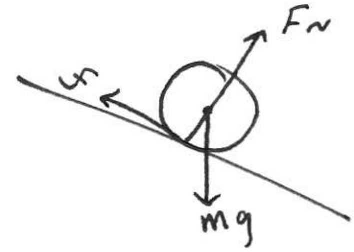
$\cancel{m}gh = \frac{3}{4}\cancel{m}v^2$

$10(8) = \frac{3}{4}v^2$

$\boxed{10.3\text{m/s} = v}$ ⟶ $w = \frac{V}{R} = \frac{10.3}{.5\text{m}}$

$\boxed{w = 20.6 \text{ RAD/s}}$

8. b. WITHOUT FRICTION, THE DISK WILL NOT BEGIN TO ROLL



· THE ONLY TORQUE IS FRICTION

· WITHOUT FRICTION, $\Sigma \tau = 0 \Rightarrow$ IT NEVER SPINS.

$\boxed{\omega = 0}$

$E_T = U_g$ ($\leftarrow$ No V, No ω)

$E_B = K$ (No ω)

$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$

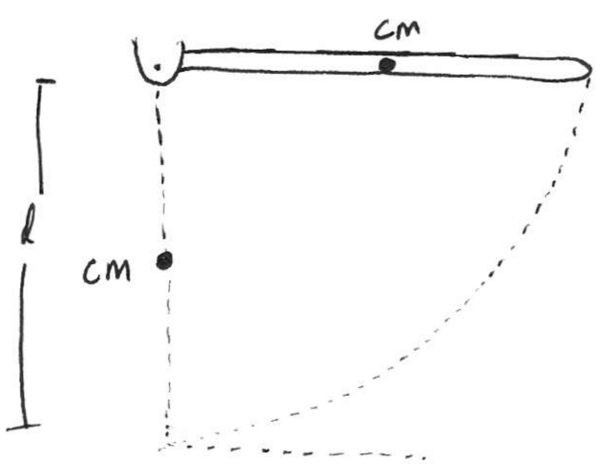
$2gh = v^2$

$\boxed{12.7 m/s = V}$

$V_b > V_a$ BECAUSE ALL OF THE POTENTIAL ENERGY BECAME KINETIC & NONE BECAME ROTATIONAL KINETIC.

c. THE HOOP HAS A GREATER ROTATIONAL INERTIA THAN THE DISK → MORE ENERGY WILL BE ROTATIONAL KE AND LESS WILL BE KINETIC (BECAUSE THE HOOP IS HARDER TO SPIN). THE HOOP WILL HAVE A SMALLER VELOCITY AND A SMALLER ANGULAR VELOCITY.

9.



a. $U_g = mg\,l/2$ ⇐ THE POTENTIAL ENERGY IS MEASURED FROM THE C.M.

$= 3(10)(1.2)/2$

$\boxed{U_g = 18 J}$

b. THE ROD WILL HAVE ROTATIONAL KE AT THE BOTTOM BECAUSE IT IS SPINNING ABOUT A POINT

c. $E_{HORIZ} = E_{VERT}$

$mg\frac{l}{2} = \frac{1}{2}I\omega^2$

$18 J = \frac{1}{2}\left(\frac{1}{3}ml^2\right)\omega^2$

$18 J = \frac{1}{2}\left(\frac{1}{3}(3kg)(1.2m)^2\right)\omega^2$

$\boxed{5 rad/s = \omega}$

d. $V = r\omega$

$V = 1.2m(5 rad/s)$

$\boxed{V = 6 m/s}$