Physics 2414
H.W. #9 solutions

1. $\boxed{7400\ rpm} \times 2\pi \frac{rad}{rotation} \times \frac{1\ min}{60 sec} = 774.9\ rad/sec$

$$\frac{0 - 774.9\ rad/sec}{\boxed{3.5\ sec}} = \underline{-221.4\ rad/s^2}$$

2. a. $\frac{2\pi \cdot \boxed{1.3 m}}{\boxed{3.9 s}} = \underline{2.09\ m/s}$

b. $a_T = \underline{0}\ m/s^2$

$$a_r = \frac{v^2}{r} = \frac{2.09^2}{\boxed{1.3 m}} = \underline{3.37\ m/s^2 \text{ to center}}$$

3. $V_i = \boxed{200\ rpm} \times \frac{\pi \boxed{0.45 m}}{rotation} \times \frac{1\ min}{60 s} = 4.712\ m/s$

$V_f = \boxed{400 rpm} \times \frac{\pi \boxed{0.45 m}}{rot.} \times \frac{1\ min}{60 s} = 9.425\ m/s$

$$\frac{(V_f + V_i)}{2} \boxed{7.5 s} = \underline{53.0\ m}$$

4. Pick clockwise as positive:

$$\tau = 0.12\,m \times 35\,N - 0.24\,m \times 28\,N + 0.24\,m \times \boxed{18\,N}$$
$$= 1.8\,mN$$

Now account for friction:

$$1.8\,mN - \boxed{0.43\,m.N} = \underline{1.37\,mN} \quad \text{clockwise}$$

5. The block on the right is farther out from the fulcrum so the system will rotate clockwise.

$$\tau = mgL_2 - mgL_1 \quad \text{clockwise}$$

enter: mg(L_2 - L_1)   clockwise

6. a. $I_{\text{solid cylinder}} = \dfrac{mr^2}{2} = \boxed{0.590\,kg} \times \boxed{0.087\,m}^2 \times 1/2$

$$= \underline{0.00223\ kg\,m^2}$$

b. $\underline{\tau = I\alpha}$ First, we must calculate the frictional torque which decelerates the wheel:

$$\alpha_d = -\frac{\boxed{1700\,rpm}}{60\,s/m} \times 2\pi \frac{rad}{rot} \Big/ \boxed{52.0\,s} = -3.42\ rad/s^2$$

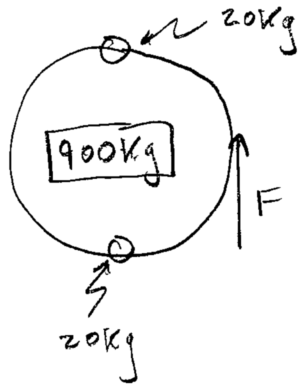
$$\tau_{friction} = I\alpha_d = -0.00764\ Nm$$

so

$$\tau_{applied} - \tau_{friction} = I\ \boxed{1700\,rpm} \times 2\pi \frac{rad}{rot} \times \frac{1\,min}{60\,s} \Big/ \boxed{2.00\,s}$$

and $\tau_{applied} = \underline{0.206\ Nm}$

7.



$r = \boxed{2.5\ m}$

$$\alpha = \frac{\boxed{20\ rpm}}{\boxed{12.0\ s}} \times 2\pi \frac{rad}{rot} \times \frac{1\ min}{60\ s} = 0.1745\ rad/s^2$$

$$I = I_{disk} + 2I_{children}$$

$$= \frac{1}{2}\boxed{900\ kg}\boxed{2.5\ m}^2 + 2 \cdot 20\ kg\ \boxed{2.5\ m}^2$$

a. $$= 3062.5\ kg\ m^2$$

$$\tau = I\alpha = 3062.5 \times 0.1745 = \underline{534.4\ Nm}$$

b. $$\tau = Fd = F \cdot \boxed{2.5\ m}$$

$$F = \underline{213.76\ N}$$

8. $$KE = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$I_{\substack{solid \\ sphere}} = \frac{2}{5}MR^2 = \boxed{6.2\ kg}\boxed{0.09\ m}^2 \frac{2}{5} = 0.02\ kg\ m^2$$

(not necessary)

$$K.E. = \frac{1}{2}mv^2 + \frac{1}{2} \cdot \frac{2}{5}mr^2\omega^2 \quad (r\omega = v)$$

$$= \frac{1}{2}mv^2 + \frac{1}{5}mv^2 = \frac{7}{10}mv^2 = \frac{7}{10}\boxed{6.2\ kg}\boxed{5.2\ m/s}^2$$

$$= \underline{117.35\ J}$$

9. $\Delta K + \Delta U = 0$ $\quad I = \frac{1}{3} m L^2$ for rod length L

$\frac{1}{2} I \omega^2 - mgh = 0$

$= \frac{1}{2} \cdot \frac{1}{3} m L^2 \omega^2 - mgh = 0$

$v = L\omega$ (For velocity at end of pole)

$h = L/2$ (this is the center of mass)

$v^2 = 6gh$ $\quad v = \sqrt{6 \cdot 9.8 \cdot \boxed{3.25\ m} / 2}$

$= \underline{9.78\ m/s}$