# Problems A chapter 8

① $\left[\frac{1}{2} I\omega^2\right] = [I][\omega^2]$

$= [kg \cdot m^2][rad/s]^2 = [kg \cdot m^2/s^2]$

$= [\underbrace{kg \cdot m/s^2}_{N} \cdot m] = [N \cdot m] = [\text{Joules}]$

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⑤ a) Mass :

density $= \rho$

$\Rightarrow M = \rho V = \rho \frac{4}{3}\pi R^3$

Thus $\frac{M_{child}}{M_{adult}} = \frac{\cancel{\rho \frac{4}{3}\pi} R_{child}^3}{\cancel{\rho \frac{4}{3}\pi} R_{adult}^3} = \left(\frac{R_{child}}{R_{adult}}\right)^3 = \left(\frac{1}{2}\right)^3$

$= \boxed{\frac{1}{8}}$

b) $I = \frac{2}{5} M R^2 \Rightarrow \frac{I_{child}}{I_{adult}} = \frac{\cancel{2/5} M_{child} R_{child}^2}{\cancel{2/5} M_{adult} R_{adult}^2}$

$= \frac{M_{child}}{M_{adult}} \cdot \frac{R_{child}^2}{R_{adult}^2}$

$= \left(\frac{1}{8}\right)\left(\frac{1}{2}\right)^2 = \boxed{\frac{1}{32}}$

(9) A significant fracti of wheel's KE is rotational.

a) So it is <u>NOT</u> justified to model the wheel as if it were sliding without friction.

b) $$\frac{K_{rotation}}{K_{total}} = \frac{4\left(\frac{1}{2}I\omega^2\right)}{\frac{1}{2}Mv^2 + 4\left(\frac{1}{2}I\omega^2\right)}$$

Divide numerator and the denominator by $\frac{1}{2}I\omega^2 \Rightarrow$

$$\frac{K_{rotation}}{K_{total}} = \frac{4}{\frac{Mv^2}{I\omega^2} + 4}$$

but $\omega = \frac{v}{r}$ ; ( $r$ = radius of the wheel)

$$\frac{Mv^2}{I\omega^2} = \frac{Mr^2\cancel{\omega^2}}{I\cancel{\omega^2}} = \frac{Mr^2}{I} = \frac{(1300)(0.35)^2}{0.705} \approx 226$$

$$= \frac{4}{226+4} = \frac{4}{230} = \boxed{0.017}$$

In this case, 1.7% of $K_{total}$ is rotational KE.

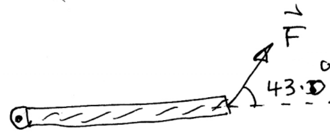
(13)

a)


$\tau = rF_\perp = rF\sin\theta = rF\cancel{\sin 90^\circ}$ $1$

$\tau = (1.26)(46.4) = \boxed{58.5\ N.m}$

b)




$\tau = rF\sin\theta = (1.26)(46.4)\sin 43^\circ = \boxed{39.9\ N.m}$

c)


$\tau = rF\sin\theta = (1.26)(46.4)\cancel{\sin 0^\circ} = \boxed{0}$ $0$

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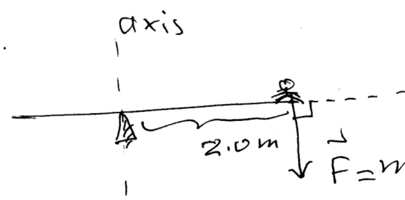
(17)




$\vec{F} = mg = (40)(9.8) = 392\ N$

$\tau = rF\sin\theta = (2)(392)(\sin 90^\circ) = \boxed{784\ N.m}$

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(25)

a) $\tau = I\alpha$

We need $I$ and $\alpha$ ; $I = mR^2 = (182)(0.62)^2 = 70 \text{ kg.m}^2$

for $\alpha$, we use $\omega_f = \cancel{\omega_i}_{0} + \alpha \Delta T$

$$\left(120 \text{ rpm} \times \frac{2\pi}{60 \text{ s}}\right) = \alpha \, (30 \text{ s}) \Rightarrow \alpha = 0.42 \text{ rad/s}^2$$

$$\tau = I\alpha = (70)(0.42) = \boxed{29.3 \text{ N.m}}$$

b) Work = ?  $W = \tau\theta$

So we need $\theta$ :  $\theta = \cancel{\omega_i}_{0} \Delta t + \frac{1}{2}\alpha \Delta t^2$

$$\theta = \left(\frac{1}{2}\right)(0.42)(30)^2 = 189 \text{ rad}$$

$$W = \text{work} = (29.3)(189) = \boxed{5538 \text{ J} \simeq 5.5 \text{ kJ}}$$

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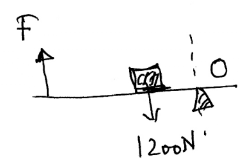
(31)




System in equilibrium

$\Sigma\tau = 0$ . With respect to Point O, $\Sigma\tau =$

$$(\Sigma\tau)_O = F(3.0) - (1200)(0.5) = 0 \Rightarrow$$

$$\boxed{F = 200 \text{ N}}$$

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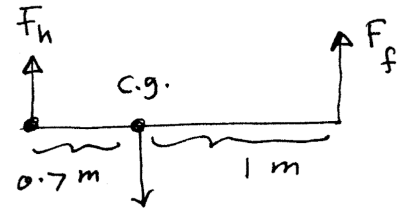
(39)




$mg = (68 \times 9.8) = 666.4 \text{ N}$

$\sum \vec{F} = 0 \Rightarrow F_h + F_f - 666.4 = 0 \Rightarrow F_h + F_f = 666.4 \quad (1)$

$\sum \tau = 0$ : choose pivot at $F_h \Rightarrow$

$(666.4)(0.7) - F_f\,(1 + 0.7) = 0 \Rightarrow \boxed{F_f = 274.4 \text{ N}}$

Using Eq. (1) $\Rightarrow \boxed{F_h = 392 \text{ N}}$

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(53) $\tau = I\alpha$ We need $I$

$I = \sum_i m_i r_i^2 = m_A r_A^2 + m_B r_B^2 + m_C r_C^2 + m_D r_D^2$

but $r_A = r_B = r_C = r_D = \frac{0.75}{2} = 0.375 \text{ m}$

$\Rightarrow I = \dots = 1.97 \text{ kg.m}^2$

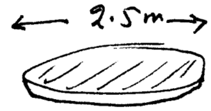
Thus $\tau = I\alpha$

$\tau = (1.97)(0.75 \text{ rad/s}^2)$

$= \boxed{1.48 \text{ N.m}}$

55

$m_{child} = 30$ kg




$M = 350$ kg

a) $\tau = I\alpha$

We need $I$ and $\alpha$.

for Calculating $\alpha$ : $\omega_f = \cancel{\omega_i}^{\,0} + \alpha \Delta t$

$$\left(25 \times \frac{2\pi}{60}\right) = \alpha(20) \Rightarrow$$

$$\boxed{\alpha = 0.13 \text{ rad/s}^2}$$

for Calculating $I$ : $I = I_{disk} + I_{children}$

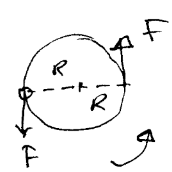
$$I = \frac{MR^2}{2} + mR^2 + mR^2$$

$$= (350)\left(\frac{2.5}{2}\right)^2\Big/2 + (30)\left(\frac{2.5}{2}\right)^2 + 30\left(\frac{2.5}{2}\right)^2$$

$$I = 367.2 \text{ kg}\cdot\text{m}^2$$

$$\tau = (367.2)(0.13) \Rightarrow \boxed{\tau = 48 \text{ N}\cdot\text{m}}$$

b)




$$\tau = FR + FR$$

$$48 = 2FR \Rightarrow$$

$$F = \frac{48}{2.5} = 19\text{N}$$

(62) $K_{total} = \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2$

a) $= \frac{1}{2} m v^2 + \frac{1}{2} (2/5\, m R^2)\, \omega^2$

using $V = R\omega \Rightarrow K_{total} = \frac{7}{10} m v^2 = \boxed{10.5\ J}$

b) $\cancel{K_i} + U_i = K_f + \cancel{U_f}$

$\quad 0 \qquad\qquad\qquad\quad 0$

$mgy_i = K_f \Rightarrow y_i = \frac{10.5\ J}{(0.6)(9.8)} = \boxed{1.79\ m}$

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(75) $L_i = 6.4\ kg.m^2/s$ and $L_f = 0$ (to stop it)

$\tau = \frac{\Delta L}{\Delta t} \Rightarrow 4 = \frac{6.4 - 0}{\Delta t}$

$\boxed{\Delta t = 1.6\ s}$

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Also check questions (78) and (79) to learn more about angular momentum.