Lösningar 4ll RÖ 3

10.5

$$\omega_i = \frac{100\text{ rev}}{1.00\text{ min}}\left(\frac{1\text{ min}}{60.0\text{ s}}\right)\left(\frac{2\pi\text{ rad}}{1.00\text{ rev}}\right) = \frac{10\pi}{3}\text{ rad/s},\ \omega_f = 0$$

(a) $$t = \frac{\omega_f - \omega_i}{\alpha} = \frac{0 - \frac{10\pi}{3}}{-2.00}\text{ s} = \boxed{5.24\text{ s}}$$

(b) $$\theta_f = \bar{\omega}t = \left(\frac{\omega_f + \omega_i}{2}\right)t = \left(\frac{10\pi}{6}\text{ rad/s}\right)\left(\frac{10\pi}{6}\text{ s}\right) = \boxed{27.4\text{ rad}}$$

10.13

Given $r = 1.00$ m, $\alpha = 4.00\ \text{rad/s}^2$, $\omega_i = 0$ and $\theta_i = 57.3° = 1.00$ rad

(a) $$\omega_f = \omega_i + \alpha t = 0 + \alpha t$$

At $t = 2.00$ s, $\omega_f = 4.00\ \text{rad/s}^2\,(2.00\text{ s}) = \boxed{8.00\ \text{rad/s}}$

(b) $$v = r\omega = 1.00\text{ m}(8.00\text{ rad/s}) = \boxed{8.00\ \text{m/s}}$$

$$|a_r| = a_c = r\omega^2 = 1.00\text{ m}(8.00\text{ rad/s})^2 = 64.0\ \text{m/s}^2$$

$$a_t = r\alpha = 1.00\text{ m}\left(4.00\ \text{rad/s}^2\right) = 4.00\ \text{m/s}^2$$

The magnitude of the total acceleration is:

$$a = \sqrt{a_r^2 + a_t^2} = \sqrt{\left(64.0\ \text{m/s}^2\right)^2 + \left(4.00\ \text{m/s}^2\right)^2} = \boxed{64.1\ \text{m/s}^2}$$

The direction of the total acceleration vector makes an angle ϕ with respect to the radius to point P:

$$\phi = \tan^{-1}\left(\frac{a_t}{a_c}\right) = \tan^{-1}\left(\frac{4.00}{64.0}\right) = \boxed{3.58°}$$

(c) $$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2 = (1.00\text{ rad}) + \frac{1}{2}\left(4.00\ \text{rad/s}^2\right)(2.00\text{ s})^2 = \boxed{9.00\text{ rad}}$$

10.17

(a) $$\omega = 2\pi f = \frac{2\pi\text{ rad}}{1\text{ rev}}\left(\frac{1\,200\text{ rev}}{60.0\text{ s}}\right) = \boxed{126\ \text{rad/s}}$$

(b) $$v = \omega r = (126\ \text{rad/s})\left(3.00\times10^{-2}\text{ m}\right) = \boxed{3.77\ \text{m/s}}$$

(c) $$a_c = \omega^2 r = (126)^2\left(8.00\times10^{-2}\right) = 1\,260\ \text{m/s}^2 \text{ so } \vec{a}_r = \boxed{1.26\ \text{km/s}^2\text{ toward the center}}$$

(d) $$s = r\theta = \omega r t = (126\ \text{rad/s})\left(8.00\times10^{-2}\text{ m}\right)(2.00\text{ s}) = \boxed{20.1\text{ m}}$$

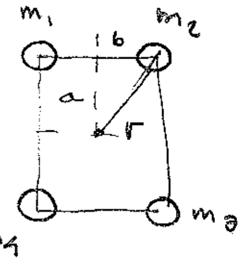
10.21

$$r_1 = r_2 = r_3 = r_4 = r$$

$$r = \sqrt{a^2+b^2} = \sqrt{3^2+2^2} = \sqrt{13}\ m$$

$$I = \sum_{i=1}^{4} m_i r^2 = (3+2+4+2)\sqrt{13}\ kgm^2 =$$

$$= \underline{\underline{143\ kgm^2}}$$

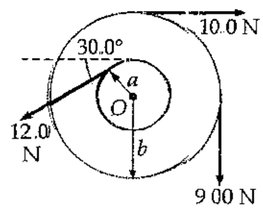


$m_1 = 3\ kg$
$m_2 = 2\ kg$
$m_3 = 4\ kg$
$m_4 = 2\ kg$

10.31

$\sum \tau = 0.100\ m(12.0\ N) - 0.250\ m(9.00\ N) - 0.250\ m(10.0\ N) = \boxed{-3.55\ N\ m}$

The thirty-degree angle is unnecessary information.



10.32 + 10.33

$$n = \frac{mg}{4} \qquad n = \text{normalkraften per hjul}$$

maximalt moment utan glidning.

$$\tau_{max} = f_{max} \cdot r = \mu_s n r =$$

$$= 0{,}800 \cdot 1500 \cdot 9{,}80 \cdot \frac{1}{4} \cdot 0{,}300 = 882\ Nm$$

samma moment måste utvecklas mellan bromsklots och hjulaxel,

$$\tau = fr = (\mu_k n) r \Rightarrow n = \frac{\tau}{\mu_k r} =$$

$$= \frac{882}{0{,}500 \cdot 0{,}22} = \underline{\underline{8{,}02\ kN}}$$

10.37

For m_1,

$$\sum F_y = ma_y: \quad +n - m_1 g = 0$$

$$n_1 = m_1 g = 19.6 \text{ N}$$

$$f_{k1} = \mu_k n_1 = 7.06 \text{ N}$$

$$\sum F_x = ma_x: \quad -7.06 \text{ N} + T_1 = (2.00 \text{ kg})a \qquad (1)$$

For the pulley,

$$\sum \tau = I\alpha: \quad -T_1 R + T_2 R = \frac{1}{2} MR^2 \left(\frac{a}{R}\right)$$

$$-T_1 + T_2 = \frac{1}{2}(10.0 \text{ kg})a$$

$$-T_1 + T_2 = (5.00 \text{ kg})a \qquad (2)$$

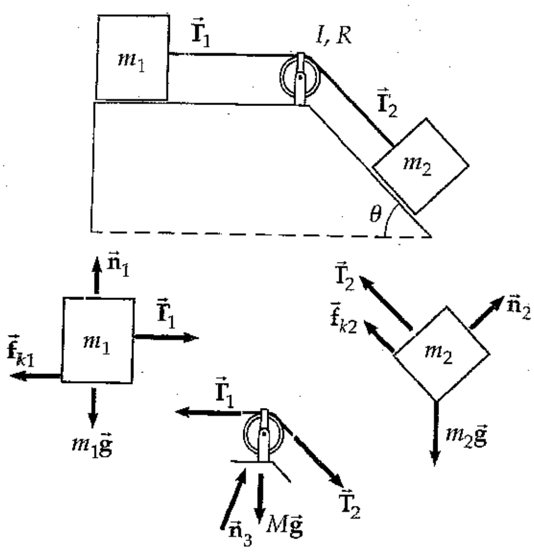


FIG. P10.62

For m_2, $\quad +n_2 - m_2 g \cos\theta = 0$

$$n_2 = 6.00 \text{ kg}\left(9.80 \text{ m/s}^2\right)(\cos 30.0°)$$
$$= 50.9 \text{ N}$$

$$f_{k2} = \mu_k n_2$$

$$= 18.3 \text{ N}: \quad -18.3 \text{ N} - T_2 + m_2 g \sin\theta = m_2 a$$

$$-18.3 \text{ N} - T_2 + 29.4 \text{ N} = (6.00 \text{ kg})a \qquad (3)$$

(a) Add equations (1), (2), and (3):

$$-7.06 \text{ N} - 18.3 \text{ N} + 29.4 \text{ N} = (13.0 \text{ kg})a$$

$$a = \frac{4.01 \text{ N}}{13.0 \text{ kg}} = \boxed{0.309 \text{ m/s}^2}$$

(b) $T_1 = 2.00 \text{ kg}\left(0.309 \text{ m/s}^2\right) + 7.06 \text{ N} = \boxed{7.67 \text{ N}}$

$T_2 = 7.67 \text{ N} + 5.00 \text{ kg}\left(0.309 \text{ m/s}^2\right) = \boxed{9.22 \text{ N}}$

10.51

(a) $K_{\text{trans}} = \frac{1}{2} mv^2 = \frac{1}{2}(10.0 \text{ kg})(10.0 \text{ m/s})^2 = \boxed{500 \text{ J}}$

(b) $K_{\text{rot}} = \frac{1}{2} I\omega^2 = \frac{1}{2}\left(\frac{1}{2} mr^2\right)\left(\frac{v^2}{r^2}\right) = \frac{1}{4}(10.0 \text{ kg})(10.0 \text{ m/s})^2 = \boxed{250 \text{ J}}$

(c) $K_{\text{total}} = K_{\text{trans}} + K_{\text{rot}} = \boxed{750 \text{ J}}$

10.77

$$\sum F = T - Mg = -Ma: \quad \sum \tau = TR = I\alpha = \frac{1}{2}MR^2\left(\frac{a}{R}\right)$$

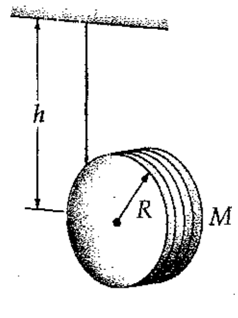


FIG. P10.65

(a) Combining the above two equations we find $T = M(g-a)$ and $a = \frac{2T}{M}$ thus $T = \boxed{\frac{Mg}{3}}$.

(b) $a = \frac{2T}{M} = \frac{2}{M}\left(\frac{Mg}{3}\right) = \boxed{\frac{2}{3}g}$

(c) $v_f^2 = v_i^2 + 2a(x_f - x_i)$ $\qquad v_f^2 = 0 + 2\left(\frac{2}{3}g\right)(h-0)$

$$v_f = \boxed{\sqrt{\frac{4gh}{3}}}$$

For comparison, from conservation of energy for the system of the disk and the Earth we have

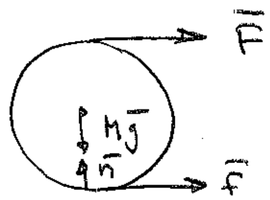
$U_{gi} + K_{\text{rot}\,i} + K_{\text{trans}\,i} = U_{gf} + K_{\text{rot}\,f} + K_{\text{trans}\,f}$: $\quad Mgh + 0 + 0 = 0 + \frac{1}{2}\left(\frac{1}{2}MR^2\right)\left(\frac{v_f}{R}\right)^2 + \frac{1}{2}Mv_f^2$

$$v_f = \sqrt{\frac{4gh}{3}}$$

10.85

a) $\sum F_x = F + f = Ma_{CM}$

$\sum \tau = FR - fR = I\alpha$



$\Rightarrow \quad FR - (Ma_{CM} - F)R = \frac{Ia_{CM}}{R} \quad \Rightarrow \boxed{a_{CM} = \frac{4F}{3M}}$

b) $f = Ma_{CM} - F = M\left(\frac{4F}{3M}\right) - F = \frac{F}{3}$

c) $v_f^2 = v_i^2 + 2a(x_f - x_i)$

$\Rightarrow v_f = \sqrt{\frac{8Fd}{3M}}$