Ex 15.1 see lecture!

Ex 15.2 straightforward

Ex 15.3 same as merry-go-round on quiz!

Ex 15.4 straightforward

Ex 15.5 $\tau = J \cdot \alpha$ (Newton!)

$|\vec{\tau}| = |\vec{R} \times \vec{F}| \underset{\vec{R} \perp \vec{F}}{=} R \cdot F \Rightarrow |\alpha| = \frac{R \cdot F}{J} =$

$= \frac{0.5\,m \cdot 10\,kg\,m}{50\,kg\,m^2} \frac{1}{s^2} = 0.1 \frac{rad}{s^2}$

$\omega = -\alpha \cdot t + \omega_0$

↑ we brake, i.e. α has opposite sign than ω_0!

at $t = t_1$ wheel at rest $\Rightarrow 0 = -\alpha t_1 + \omega_0$

$\Rightarrow t_1 = \frac{\omega_0}{\alpha} = \frac{\omega_0 \cdot J}{R \cdot F} = \frac{10 \frac{rad}{s} \cdot 50\,kg\,m^2 s^2}{0.5\,m \cdot 10\,kg\,m} = 100\,s$

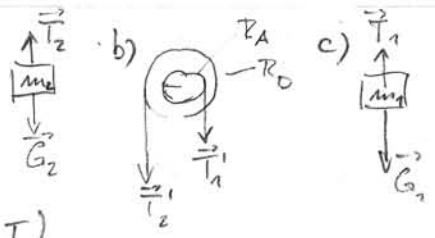
$\theta(t_1) = -\frac{1}{2} \alpha t_1^2 + \omega_0 t_1 =$

$= -\frac{1}{2} 0.1 \frac{rad}{s^2} \cdot (100\,s)^2 + 10 \frac{rad}{s} \cdot 100\,s$

$= -500\,rad + 1000\,rad = 500\,rad$

No. of rev. $n = \frac{\theta(t_1)}{2\pi} = 79.58$ rev.

Ex 15.6



a) $m_2 a_2 = \sum \vec{F} = T_2 - m_2 g$

b) $J\alpha = (R_D T_2 - R_A T_1)$

counter-clock clockwise

c) $m_1 a_1 = T_1 - m_1 g$

(a) $\Rightarrow T_2 = m_2 (a_2 + g)$ } in (b) $\Rightarrow J\alpha = R_D m_2 (a_2 + g) -$

(c) $\Rightarrow T_1 = m_1 (a_1 + g)$ } $R_A m_1 (a_1 + g)$

replace α and a_1 by expressions containing a_2 by using „does not slip", i.e $\alpha = \frac{a_2}{R_D}$

and $a_1 = R_A \alpha = \frac{R_A}{R_D} a_2$

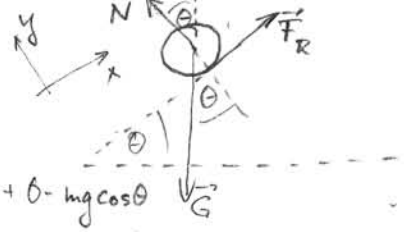
$\Rightarrow J \frac{a_2}{R_D} = R_D m_2 a_2 + R_D m_2 g - R_A m_1 \frac{R_A}{R_D} a_2 - R_A m_1 g$

$\Rightarrow J a_2 = R_D^2 m_2 a_2 + R_D^2 m_2 g - R_A^2 m_1 a_2 - R_A R_D m_1 g$

$\Rightarrow a_2 (J - R_D^2 m_2 + R_A^2 m_1) = R_D^2 m_2 g - R_A R_D m_1 g$

$\Rightarrow$ solution in book ...

Ex 15.7



Newton for y:

$F_y = m a_y = 0$

$F_y = N_y + F_{Ry} + G_y = N + 0 - mg\cos\theta$

$\Rightarrow N = mg\cos\theta$ (1)

Newton for x:

$F_x = m a_x$; $F_x = N_x + F_{Rx} + G_x = 0 + \mu N - mg\sin\theta$

$\Rightarrow m a_x = \mu \underbrace{mg\cos\theta}_{=N} - mg\sin\theta$ (2)

$a_x = g(\mu\cos\theta - \sin\theta)$

Newton for Rotation:

$\tau = J \cdot \alpha = \underbrace{\frac{1}{2} m R^2}_{=J} \cdot \frac{\overbrace{-a_x}^{\text{center of mass and point on circumference accelerate in opposite direction!}}}{R}$

↑ „does not slip"

$R \cdot F_R = R \mu N = R \mu m g \cos\theta$

$\Rightarrow R\mu mg\cos\theta = -\frac{1}{2} m R a_x \Rightarrow a_x = -2\mu g\cos\theta$

(2) $\Rightarrow -2\mu g\cos\theta = \mu g\cos\theta - g\sin\theta$

$\Rightarrow -3\mu g\cos\theta = -g\sin\theta$

$\Rightarrow \mu = \frac{1}{2}\tan\theta$