2.20

$\omega_0 = 0$

$\alpha = kt$

$k = 0.08\ s^{-3}$

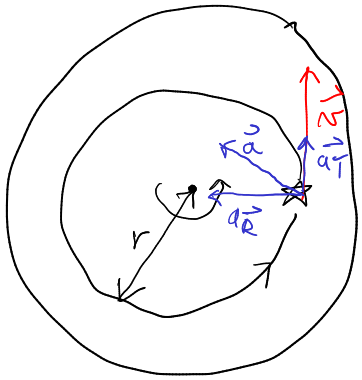
$N = 1$

$r = 30\ cm$

$v_1 = ?$

$a_1 = ?$

$\vec{a} = \vec{a}_R + \vec{a}_T$



$\varphi_1 = N \cdot 2\pi$

$\varphi(t) \rightarrow \omega(t) = \varphi'(t) \rightarrow \alpha(t) = \omega'(t) = \varphi''(t)$

$\varphi(t) = \int_0^t \omega(t')\,dt'$

$\omega(t) = \int_0^t \alpha(t')\,dt'$

$$\omega(t) = \int_0^t kt'\,dt' = \frac{t'^2}{2}\Big|_0^t = \frac{kt^2}{2}$$

$$\varphi(t) = \int_0^t \frac{kt'^2}{2}\,dt' = \frac{k}{2}\,\frac{t'^3}{3}\Big|_0^t = \frac{kt^3}{6}$$

$$\varphi_1 = N \cdot 2\pi = \frac{kt_1^3}{6}$$

ob času t_1 naredi ploščica 1. obrat

$$t_1 = \left(\frac{12\pi N}{k}\right)^{1/3}$$

$v_1 = \omega_1 \cdot r$

$a_1 = |\vec{a}_1| = \sqrt{a_R^2 + a_T^2}$

$a_R = r\omega_1^2$

$a_T = r\alpha_1$

$$\omega_1 = \frac{k}{2}t_1^2 = \frac{k}{2}\left(\frac{12\pi N}{k}\right)^{2/3}$$

$$\alpha_1 = kt_1 = k\left(\frac{12\pi N}{k}\right)^{1/3}$$

$$v_1 = r\frac{k}{2}\left(\frac{12\pi N}{k}\right)^{2/3} = 0.73\ m/s$$

$$a_1 = \sqrt{(r\omega_1^2)^2 + (r\alpha_1)^2} = r\sqrt{\omega_1^4 + \alpha_1^2} =$$

$$= r\sqrt{\left(\frac{k}{2}\left(\frac{12\pi N}{k}\right)^{2/3}\right)^4 + \left(k\left(\frac{12\pi N}{k}\right)^{1/3}\right)^2} = rk^{2/3}\sqrt{\frac{(12\pi N)^{8/3}}{16} + (12\pi N)^{2/3}} =$$

$$= 1.77\ m/s^2$$

2.22

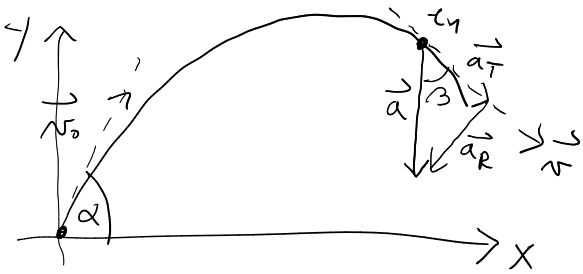
$\alpha = 60°$

$v_0 = 20\ m/s$

$t_1 = 3\ s$

$a_R = ?$

$a_T = ?$



$|\vec{a}| = g$

$\vec{a} = \vec{a_R} + \vec{a_T}$

$\vec{v}(t_1) = ?$

$\vec{a} = (0, -g)$

$\vec{v} = (v_x, v_y)$

$v_x = v_0 \cos\alpha$

$v_y = v_0 \sin\alpha - g t$

$\vec{v}(t_1) = (v_0 \cos\alpha,\ v_0 \sin\alpha - g t_1)$

$|\vec{v}(t_1) \times \vec{a}| = v(t_1) \cdot a \sin\beta$ ($a \sin\beta = a_R$)

$a_R = \frac{|\vec{v}(t_1) \times \vec{a}|}{v(t_1)} \dots$

$\vec{v}(t_1) \cdot \vec{a} = v(t_1) \cdot a \cdot \cos\beta$ ($a \cdot \cos\beta = a_T$)

$a_T = \frac{\vec{v}(t_1) \cdot \vec{a}}{v(t_1)} = \frac{-g(v_0 \sin\alpha - g t_1)}{\sqrt{(v_0 \cos\alpha)^2 + (v_0 \sin\alpha - g t_1)^2}} =$

$= 7.56\ m/s^2$

$a^2 = a_R^2 + a_T^2$

$a_R = \sqrt{a^2 - a_T^2} = \sqrt{g^2 - a_T^2} = 6.25\ m/s^2$

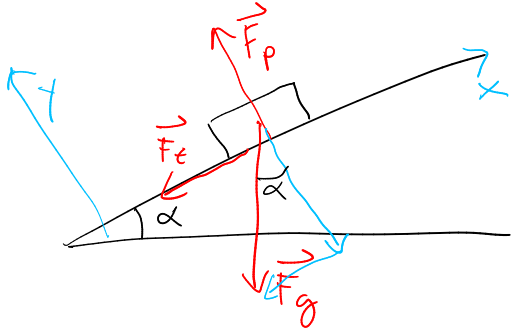
3.1

$\alpha = 10°$

$v_0 = 14\,m/s$

$s = 20\,m$

$k_t = 0{,}1$



$\sum \vec{F} = m\vec{a}$

2. Newtonov zakon

v

$\vec{F_g} + \vec{F_p} + \vec{F_t} = m\vec{a}$

x: $-mg\sin\alpha + 0 - F_t = ma$

y: $-mg\cos\alpha + F_p + 0 = 0 \rightarrow F_p = mg\cos\alpha$

$F_t = k_t \cdot F_p \rightarrow F_t = k_t\, mg\cos\alpha$

$-mg\sin\alpha - k_t\, mg\cos\alpha = ma$

$a = -g(\sin\alpha + k_t\cos\alpha)$

$v^2 = v_0^2 + 2as$

$v = \sqrt{v_0^2 - 2g(\sin\alpha + k_t\cos\alpha)\,s} = 9.45\ m/s$

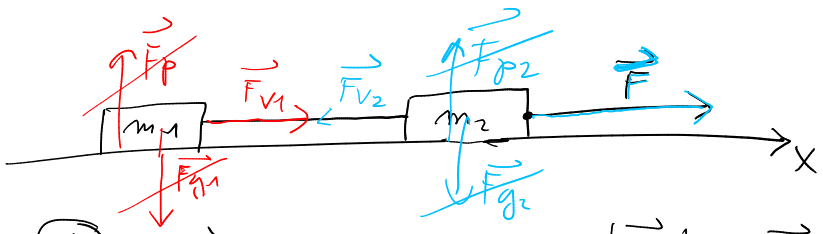
3.5

$m_1 = 1.5\ kg$

$m_2 = 2\ kg$

$F_V = 60N$

$F_{max} = ?$



1. $\vec{F}_{V_1} = m_1 \vec{a}_1$

2. $\vec{F} + \vec{F}_{V_2} = m_2 \vec{a}_2$

$|\vec{F}_{V_1}| = |\vec{F}_{V_2}| = F_V$

3. Newtonov zakon

$|\vec{a}_1| = |\vec{a}_2| = a$

X: $F_V = m_1 a \rightarrow a = \frac{F_V}{m_1}$

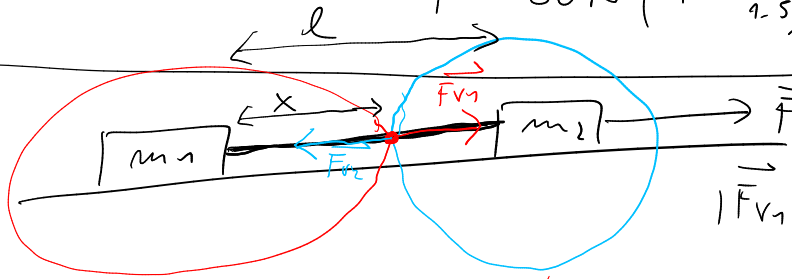
$F - F_V = m_2 a$

$F - F_V = \frac{m_2}{m_1} F_V$

$F_V \left(1 + \frac{m_2}{m_1}\right) = F$

$F = 60N \left(1 + \frac{2\ kg}{1.5\ kg}\right) = 140\ N$

$m_V = 0.1\ kg$



$|\vec{F}_{V_1}| = |\vec{F}_{V_2}| = F_V$

$F_V = \left(m_1 + m_V \frac{x}{l}\right) a \rightarrow a = \frac{F_V}{m_1 + m_V \frac{x}{l}}$

$F - F_V = \left(m_2 + m_V \frac{l-x}{l}\right) a$

$F - F_V = \frac{m_2 + m_V \frac{l-x}{l}}{m_1 + m_V \frac{x}{l}} F_V$

$F = F_V \left(1 + \frac{m_2 + m_V \frac{l-x}{l}}{m_1 + m_V \frac{x}{l}}\right)$

$F = F_V \frac{m_1 + m_2 + m_V}{m_1 + m_V \frac{x}{l}}$

$F_V = F \frac{m_1 + m_V \frac{x}{l}}{m_1 + m_2 + m_V} = F_V(x)$

$F_V(x) = max.$ pri $x = l$

$x = l$

$F = F_V \frac{m_1 + m_2 + m_V}{m_1 + m_V}$

$= 60 \frac{3.6}{1.6} N =$

$= 135N$

3.7

$m_1 = 1\ kg$

$m_2 = 2\ kg$

$\alpha = 30°$

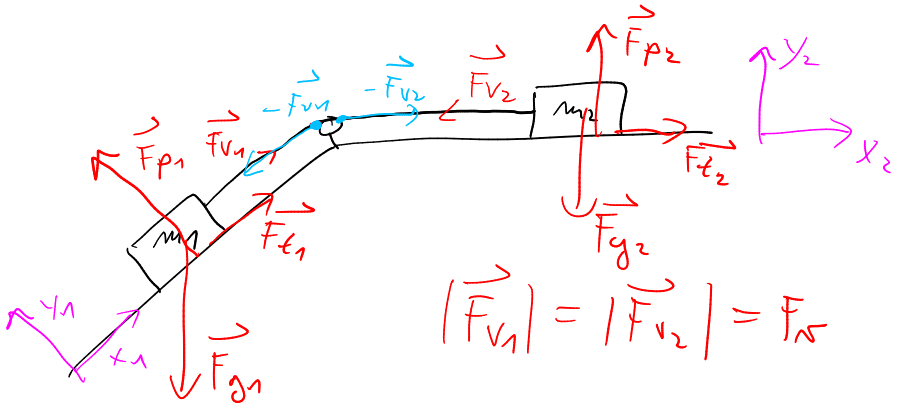
$k_t = 0.1$

$p = 10\%$

$a = ?$

$F_V = ?$

$\Delta a = ?$



$|\vec{F}_{v1}| = |\vec{F}_{v2}| = F_V$

1.) $\vec{F}_{g1} + \vec{F}_{p1} + \vec{F}_{v1} + \vec{F}_{t1} = m_1 \vec{a}_1$

2.) $\vec{F}_{g2} + \vec{F}_{p2} + \vec{F}_{v2} + \vec{F}_{t2} = m_2 \vec{a}_2$

$|\vec{a}_1| = |\vec{a}_2| = a$

1.) x_1: $-m_1 g \sin\alpha + F_V + F_{t1} = m_1 a$

y_1: $-m_1 g \cos\alpha + F_{p1} = 0$

$F_{t1} = F_{p1} k_t$

2.) x_2: $-F_V + F_{t2} = m_2 a$

y_2: $-m_2 g + F_{p2} = 0$

$F_{t2} = F_{p2} k_t$

$F_{t1} = m_1 g \cos\alpha\, k_t$

$F_{t2} = m_2 g\, k_t$

1.) $-m_1 g \sin\alpha + F_V + m_1 g \cos\alpha\, k_t = m_1 a$

2.) $-F_V + m_2 g\, k_t = m_2 a$

Σ: $-m_1 g \sin\alpha + m_1 g \cos\alpha\, k_t + m_2 g\, k_t = (m_1 + m_2) a$

$$a = g\,\frac{-m_1 \sin\alpha + k_t (m_1 \cos\alpha + m_2)}{m_1 + m_2}$$

$a = -0.7\ m/s^2$

$F_V = m_2 (g k_t - a) = 3.36\ N$

$k_t \to k_t (1+p) = k_t (1 + 10\%) = k_t \cdot 1{,}1 = 0{,}11$

$$\Delta a = g\,\frac{\Delta k_t (m_1 \cos\alpha + m_2)}{m_1 + m_2} \qquad \Delta k_t = p\, k_t$$

$$\Delta a = g\,\frac{p\, k_t (m_1 \cos\alpha + m_2)}{m_1 + m_2} = 0.094\ m/s^2$$

3. 6

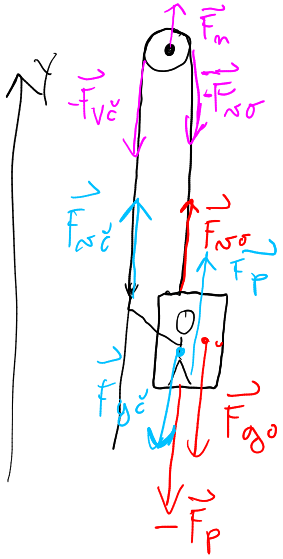
$m_o = 30\,kg$

$m_č = 90\,kg$

$F_p = 500\,N$

$a = ?$

$F_m = ?$



o: $\vec{F}_{No} + \vec{F}_{go} - \vec{F}_p = m_o \vec{a}_o$

č: $\vec{F}_{Nč} + \vec{F}_{gč} + \vec{F}_p = m_č \vec{a}_č$

$|\vec{a}_o| = |\vec{a}_č| = a$

$|\vec{F}_{Nč}| = |\vec{F}_{No}| = F_N$

y: $F_N - m_o g - F_p = m_o a$

$F_N - m_č g + F_p = m_č a$

$-$: $(-m_o + m_č)g - 2F_p = (m_o - m_č)a$

$a = -g + \frac{2F_p}{m_č - m_o} =$

$= -10\,\frac{m}{s^2} + \frac{2 \cdot 500\,N}{60\,kg} =$

$= \frac{40}{6}\,m/s^2 = 6.7\,m/s^2$

$\vec{F}_m - \vec{F}_{Už} - \vec{F}_{No} = 0$

$F_m = 2F_V$

$2F_V = (m_o + m_č)(a + g) =$

$F_m = (m_o + m_č)(a + g) =$

$= 120\,kg \cdot (\frac{40}{6} + 10)\,m/s^2 = 1000\,N$