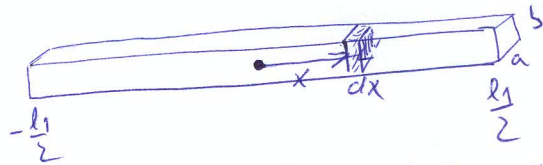
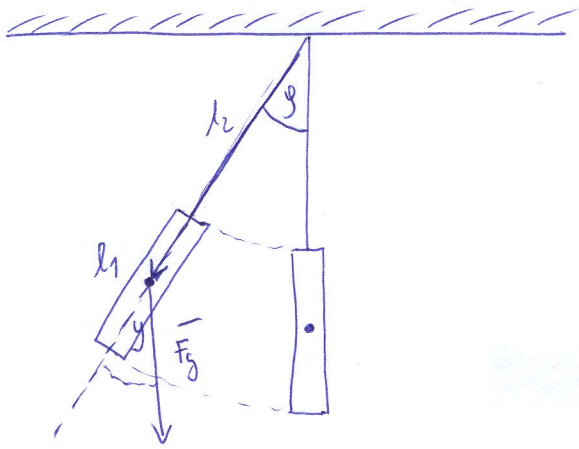


①



$$dm = \rho dV = \frac{m}{a \cdot l_1} \cdot a b dx = \frac{m}{l_1} dx$$

$$a) J_T = \int_{-\frac{l_1}{2}}^{\frac{l_1}{2}} dm x^2 = \int_{-\frac{l_1}{2}}^{\frac{l_1}{2}} \frac{m}{l_1} x^2 dx = \frac{m}{l_1} \left[\frac{x^3}{3} \right]_{-\frac{l_1}{2}}^{\frac{l_1}{2}} = \frac{m}{l_1} \left(\frac{l_1^3}{24} + \frac{l_1^3}{24} \right) = \frac{1}{12} m l_1^2 \quad 1b$$

$$J = J_T + m \left(l_2 + \frac{l_1}{2} \right)^2 = \frac{1}{12} m l_1^2 + m \left(l_2 + \frac{l_1}{2} \right)^2 = \frac{1}{12} \cdot 2,5 \cdot (0,5)^2 + 2,5 \cdot (1,25)^2 = 3,1 \quad \frac{9,58 \text{ kgm}^2}{0,5b}$$

$$b) \vec{M} = \vec{v} \times \vec{F}_g$$

$$\vec{M} = -J \ddot{\varphi} \quad 0,5b$$

$$\vec{v} \times \vec{F}_g = -J \ddot{\varphi}$$

$$\left(l_2 + \frac{l_1}{2} \right) \cdot m g \sin \varphi = -J \ddot{\varphi}$$

$$J \ddot{\varphi} + \left(l_2 + \frac{l_1}{2} \right) m g \sin \varphi = 0 \quad \begin{matrix} \varphi \rightarrow 0 \\ \sin \varphi \rightarrow \varphi \end{matrix}$$

$$\ddot{\varphi} + \frac{\left(l_2 + \frac{l_1}{2} \right) m g}{J} \varphi = 0 \quad 0,5b$$

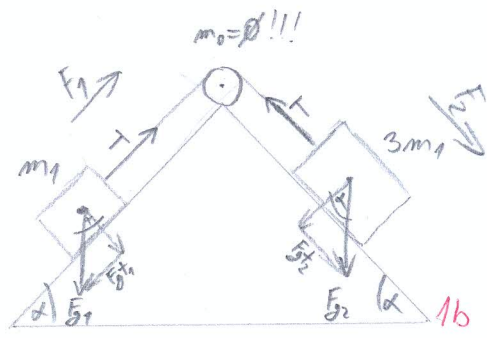
$$\omega_0^2$$

$$\omega_0 = \frac{2\pi}{T} = \sqrt{\frac{\left(l_2 + \frac{l_1}{2} \right) m g}{J}}$$

$$T = 2\pi \sqrt{\frac{J}{\left(l_2 + \frac{l_1}{2} \right) m g}} = 2\pi \sqrt{\frac{\frac{1}{12} m l_1^2 + m \left(l_2 + \frac{l_1}{2} \right)^2}{\left(l_2 + \frac{l_1}{2} \right) m g}} = 2\pi \sqrt{\frac{\frac{1}{12} l_1^2 + \left(l_2 + \frac{l_1}{2} \right)^2}{\left(l_2 + \frac{l_1}{2} \right) g}} \quad 0,5b$$

$$= 2\pi \sqrt{\frac{\frac{1}{12} \cdot 0,5^2 + (1,25)^2}{1,25 \cdot 9,87}} = 2,258 \text{ s} \quad 0,5b$$

2



$$F_1 = T - F_{1t}$$

$$F_2 = F_{2t} - T \quad 1b$$

$$m_1 \cdot a = T - m_1 g \sin \alpha \Rightarrow T$$

$$3m_1 \cdot a = 3m_1 g \sin \alpha - T$$

$$T = m_1 a + m_1 g \sin \alpha$$

$$3m_1 a = 3m_1 g \sin \alpha - m_1 a - m_1 g \sin \alpha$$

$$4m_1 a = 2m_1 g \sin \alpha$$

$$a = \frac{1}{2} g \sin \alpha \quad 1b$$

$$3) m = 2 \text{ kg}$$

$$h = 10 \text{ m}$$

$$W = ? \text{ [J]}$$

$$k = ? \text{ [Nm}^{-1}\text{]}$$

$$x = 5 \text{ mm} = 0,005 \text{ m}$$

$$a) W = m \cdot g \cdot h \text{ 1b } | \quad g = 9,81 \text{ ms}^{-2}$$

$$W = \cancel{10} 2 \cdot 9,81 \cdot 10$$

$$W = \underline{196,2 \text{ J}} \text{ 0,5b}$$

$$b) |\vec{F}_g| = |\vec{F}|$$

$$m \cdot g = k \cdot x$$

$$k = \frac{m \cdot g}{x} \text{ 1b}$$

$$k = \frac{2 \cdot 9,81}{0,005} = \underline{3924 \text{ Nm}^{-1}} \text{ 0,5b}$$