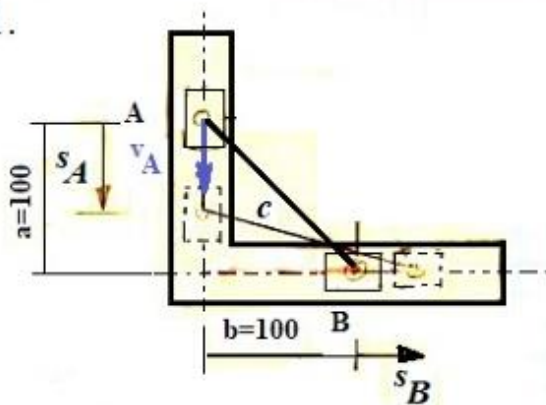


Musterlösung 1. Probeklausur TM2 – 2025

Musterlösung 1. Probeklausur TM2 – Kinematik/Kinetik

1.



$$(s_B + b)^2 + (a - s_A)^2 = c^2$$

$$s_A = v_A \cdot t$$

$$(s_B + b)^2 = c^2 - (a - v_A t)^2$$

$$s_B + b = [c^2 - (a - v_A t)^2]^{\frac{1}{2}}$$

$$s_B = [c^2 - (a - v_A t)^2]^{\frac{1}{2}} - b$$

$$s_B \text{ für } t = 0,5 \text{ s}$$

$$s_B = 32,3 \text{ mm}$$

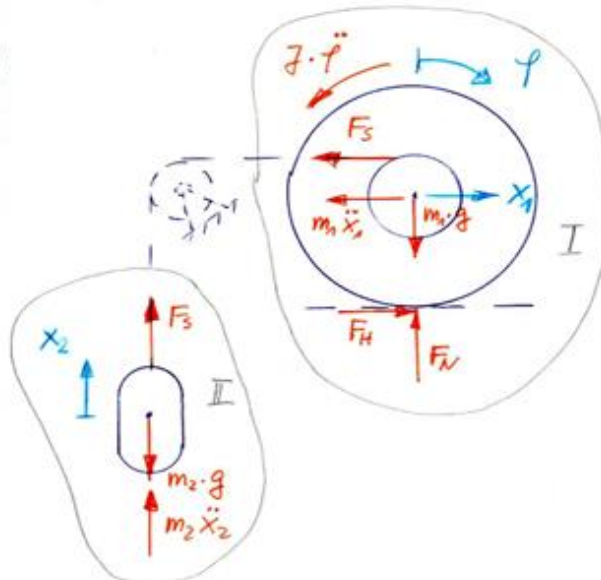
2.

$$\text{II: } \uparrow: F_S - m_2 \cdot g - m_2 \ddot{x}_2 = 0$$

$$\text{I: } \curvearrowright B: J \ddot{\varphi} - M + F_S \cdot (R + r) + m_1 \ddot{x}_1 \cdot R = 0$$

$$F_S = m_2 g + m_2 \ddot{x}_2$$

$$F_S = \frac{-J \ddot{\varphi} + M - m_1 \ddot{x}_1 \cdot R}{R + r}$$



$$(m_2 g + m_2 \ddot{x}_2)(R + r) = M - J \ddot{\varphi} - m_1 \ddot{x}_1 \cdot R$$

$$\text{Zwangsbed. : } \frac{x_1}{R} = \frac{x_2}{R + r} \Rightarrow \ddot{x}_1 = \frac{R}{R + r} \ddot{x}_2$$

$$\text{Rollbed. } x_1 = R \cdot \varphi \Rightarrow \ddot{\varphi} = \frac{\ddot{x}_1}{R} = \frac{\ddot{x}_2}{R + r}$$

$$m_2 \cdot g + m_2 \ddot{x}_2 = \frac{M}{R + r} - J \cdot \frac{\ddot{x}_2}{(R + r)^2} - m_1 \cdot \frac{R^2}{(R + r)^2} \cdot \ddot{x}_2$$

$$\ddot{x}_2 \left[m_2 + m_1 \frac{R^2}{(R + r)^2} + \frac{J}{(R + r)^2} \right] = \frac{M}{R + r} - m_2 \cdot g$$

$$\ddot{x}_2 \left[10 + 30 \left(\frac{0,3}{0,5} \right)^2 + \frac{3 \cdot 30 \cdot 0,2^2}{0,5^2} \right] = \frac{60}{0,5} \text{ N} - 10 \cdot 9,81 \text{ N}$$

$$\ddot{x}_2 = \frac{21,9 \text{ N}}{35,2 \text{ kg}} = 0,62 \frac{\text{m}}{\text{s}^2}$$

3. Aufg. (1. Pr. - Kl.)

a) $\frac{1}{2} c s^2 = \frac{1}{2} m_1 v_1^2$

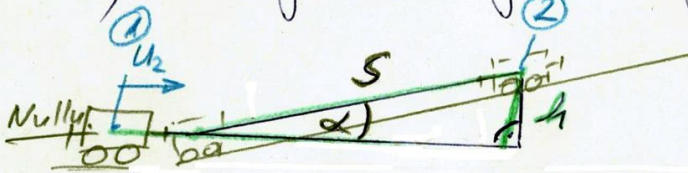
$$v_1 = \sqrt{\frac{c \cdot s^2}{m_1}} = \sqrt{\frac{1,5 \text{ N} \cdot 40^2 \text{ mm}^2}{\text{mm} \cdot 12 \text{ kg}}} = \sqrt{\frac{200 \text{ kg m} \cdot \text{mm}}{\text{s}^2 \cdot \text{kg}}}$$

$$v_1 = \sqrt{200 \cdot 10^{-3}} \frac{\text{m}}{\text{s}} = 0,447 \frac{\text{m}}{\text{s}}$$

b) $m_1 v_1 = m_1 u_1 + m_2 u_2$ $\left\{ \begin{array}{l} u_1 = 0,27 \frac{\text{m}}{\text{s}} \\ u_2 = 0,54 \frac{\text{m}}{\text{s}} \end{array} \right.$

$$k = \frac{u_1 - u_2}{-v_1}$$

c) Energiesatz für Wagen 2 (m_2)



$$\frac{1}{2} m_2 u_2^2 = m_2 \cdot g \cdot h$$

$$h = s \cdot \sin \alpha$$

$$\frac{1}{2} u_2^2 = g \cdot s \cdot \sin \alpha \Rightarrow \underline{\underline{s = \frac{u_2^2}{2 \cdot g \cdot \sin \alpha} = 0,85 \text{ m}}}$$

$$4.9) m_{\text{ges}} = m_{\text{Schulbo}} + 2 \cdot m_{\text{Welle}} - 4 \cdot m_{\text{Bohrungen}}$$

$$m_{\text{Sch}} = \rho \cdot \frac{\pi \cdot 0,8^2 \text{ dm}^2}{4} \cdot 0,2 \text{ dm} = 0,789 \text{ kg}$$

$$m_{\text{W}} = \rho \cdot \frac{\pi \cdot 0,2^2}{4} \cdot 0,2 \text{ kg} = 0,049 \text{ kg}$$

$$m_{\text{B}} = m_{\text{W}} = 0,049 \text{ kg}$$

$$m_{\text{ges}} = 0,789 + 2 \cdot 0,049 - 4 \cdot 0,049 = 0,691 \text{ kg}$$

$$b) J_{\text{ges}} = J_{\text{Sch}} + 2 \cdot J_{\text{W}} - 4(J_{\text{B}} + m_{\text{B}} \cdot r_{\text{B}}^2)$$

$$J_{\text{Sch}} = \frac{1}{2} m_{\text{Sch}} \cdot 40^2 = 631 \text{ kg mm}^2$$

$$J_{\text{W}} = \frac{1}{2} m_{\text{W}} \cdot 10^2 = 2,45 \text{ kg mm}^2$$

$$J_{\text{B}} = \frac{1}{2} m_{\text{B}} \cdot 10^2 = 2,45 \text{ kg mm}^2$$

$$r_{\text{B}} = 25 \text{ mm}$$

$$J_{\text{ges}} = 631 + 2 \cdot 2,45 - 4(2,45 + 0,049 \cdot 25^2) \text{ kg mm}^2$$

$$J_{\text{ges}} = 636,9 - 4(33,1) \text{ kg mm}^2$$

$$J_{\text{ges}} = \underline{\underline{504 \text{ kg mm}^2}}$$

$$5. a) \quad m_1 = m_D - m_d = \rho \cdot s \cdot \frac{\pi}{4} (D^2 - d^2)$$

$$m_D = \rho \cdot s \cdot \frac{\pi \cdot D^2}{4} = 2,7 \cdot 0,8 \cdot \frac{\pi \cdot 2^2}{4} = 6,79 \text{ kg}$$

$$m_d = \rho \cdot s \cdot \frac{\pi d^2}{4} = 2,7 \cdot 0,8 \cdot \frac{\pi \cdot 1^2}{4} = 1,70 \text{ kg}$$

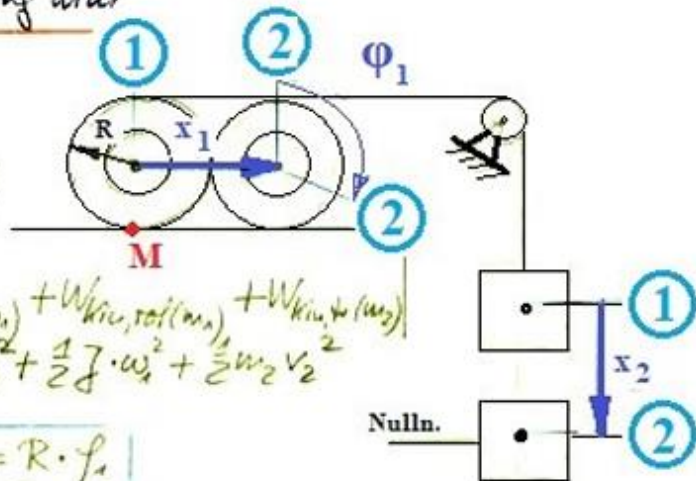
$$\underline{m_1 = 6,79 - 1,7 = 5,09 \text{ kg}}$$

$$J_{ges} = J_D - J_d = \frac{1}{2} m_D \cdot R^2 - \frac{1}{2} m_d \cdot r^2$$

$$= \frac{1}{2} (6,79 \cdot 100^2 - 1,7 \cdot 50^2) \text{ kg mm}^2$$

$$\underline{J_{ges} = 31825 \text{ kg mm}^2}$$

b) Energiesatz
(Hohlrad rollt)



$$W_{pot}(m_2) = W_{kin,trans}(m_1) + W_{kin,rot}(m_1) + W_{kin,trans}(m_2)$$

$$m_2 \cdot g \cdot x_2 = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} J \cdot \omega_1^2 + \frac{1}{2} m_2 v_2^2$$

Zwangsbed.

$$x_1 = R \cdot \varphi_1$$

$$v_1 = R \cdot \omega_1$$

$$x_2 = 2 \cdot x_1 \quad (\text{Normalkar. pol.})$$

$$v_2 = 2 \cdot v_1$$

Massenträgheitsmoment: $J = J_{ges} \cdot (s.c.)$

$$m_2 \cdot g \cdot x_2 = \frac{1}{2} m_1 \cdot \left(\frac{v_2}{2}\right)^2 + \frac{1}{2} J \cdot \left(\frac{v_2}{R}\right)^2 + \frac{1}{2} m_2 \cdot v_2^2$$

$$m_2 \cdot g \cdot x_2 = \frac{1}{2} m_1 \cdot \frac{v_2^2}{4} + \frac{1}{2} J \cdot \frac{v_2^2}{4R^2} + \frac{1}{2} m_2 v_2^2$$

$$v_2^2 \left(\frac{1}{8} m_1 + \frac{1}{8} \frac{J}{R^2} + \frac{1}{2} m_2 \right) = m_2 \cdot g \cdot x_2$$

$$v_2 = \sqrt{\frac{m_2 \cdot g \cdot x_2}{\left(\frac{1}{8} m_1 + \frac{1}{8} \frac{J}{R^2} + \frac{1}{2} m_2 \right)}} = \sqrt{\frac{24,5 \text{ kg} \cdot \frac{\text{m}}{\text{s}^2} \cdot \text{m}}{\left(\frac{5,09}{8} + \frac{5}{2} + \frac{0,031}{8 \cdot 0,1^2} \right) \text{ kg}}}$$

$$\underline{v_2 = \sqrt{\frac{24,5}{3,52}} \frac{\text{m}}{\text{s}}} = 2,64 \text{ m/s}$$