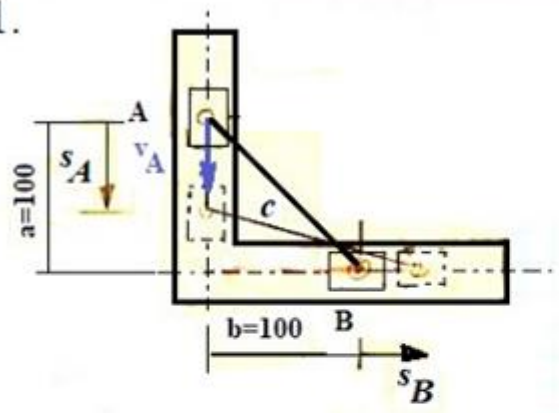
Musterlösung 1. Probeklausur TM2

Musterlösung 1. Probeklausur TM2 – Kinematik/Kinetik

1.



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

$$s_A = v_A \cdot t$$

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

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

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

s_B für $t = 0{,}5\ s$

$s_B = 32{,}3\ mm$

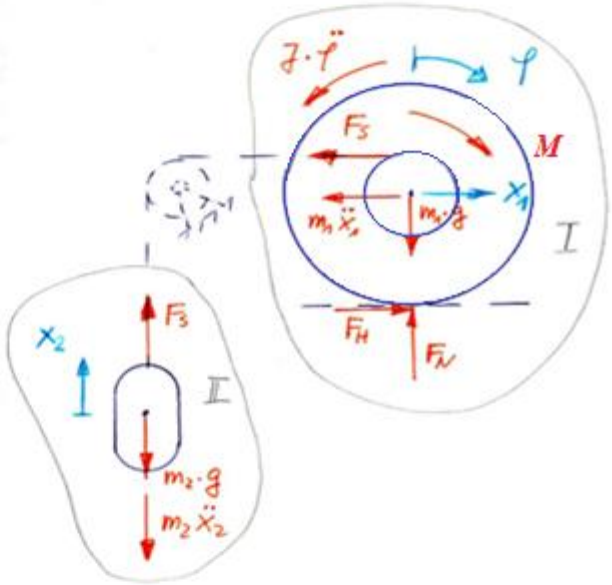
2.

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

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

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

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



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

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

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

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

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

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

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

3. Aufg. (1. Pr. – Kl.)

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

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

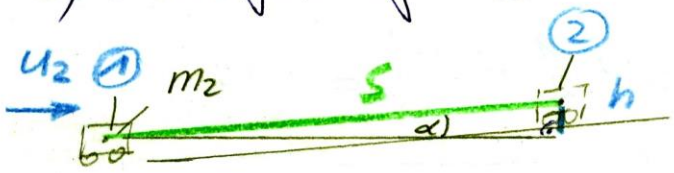
$$v_1 = \sqrt{200 \cdot 10^{-3}}\ \frac{m}{s} = 0{,}447\ \frac{m}{s}$$

b) $m_1 v_1 = m_1 u_1 + m_2 u_2$

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

$\left.\begin{array}{l} u_1 = 0{,}27\ \frac{m}{s} \\ u_2 = 0{,}54\ \frac{m}{s} \end{array}\right\}$

c) E-Satz für Wagen 2



$\sin\alpha = \frac{h}{s} \Rightarrow h = s \cdot \sin\alpha$

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

$\frac{1}{2} u_2^2 = g \cdot s \cdot \sin\alpha$

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

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

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

$$m_W = \varrho \cdot \frac{\pi \cdot 0{,}2^2}{4} \cdot 0{,}2\,kg = 0{,}049\,kg$$

$$m_B = m_W = 0{,}049\,kg$$

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

b) $J_{ges} = J_{Sch} + 2 \cdot J_W - 4\left(J_B + m_B \cdot r_B^2\right)$

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

$$J_W = \frac{1}{2} m_W \cdot 10^2 = 2{,}45\,kg\,mm^2$$

$$J_B = \frac{1}{2} m_B \cdot 10^2 = 2{,}45\,kg\,mm^2$$

$$r_B = 25\,mm$$

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

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

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

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

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

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

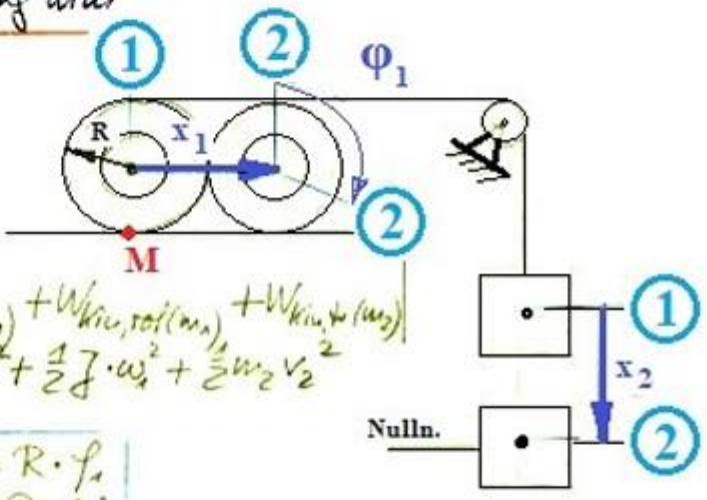
$m_1 = 6{,}79 - 1{,}7 = 5{,}09\,kg$

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

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

$J_{ges} = 31\,825\,kg\,mm^2$

b) Energiesatz (Hohlrad rollt)



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

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

Zwangsbed. $x_1 = R \cdot \varphi_1$

$v_1 = R \cdot \omega_1$

$x_2 = 2 \cdot x_1$ (Momentanpol)

$v_2 = 2 \cdot v_1$

Massenträgheit: $J = J_{ges} \cdot (s.o.)$

$m_2 \cdot g \cdot x_2 = \frac{1}{2} m_1 \cdot \left(\frac{v_2}{2}\right)^2 + \frac{1}{2} J \cdot \left(\frac{v_1}{R}\right)^2 + \frac{1}{2} m_2 \cdot v_2^2$

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

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

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

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