Internationales / International Affairs
Studienkolleg / Preparatory School

Technische Universität Berlin

Schriftliche Prüfung zur Feststellung der Eignung ausländischer Studienbewerberinnen und Studienbewerber zum Hochschulstudium im Land Berlin für naturwissenschaftliche und technische Studiengänge (Feststellungsprüfung für T-Kurse)

Physik (T-Kurs) – Prüfungsbeispiel 2

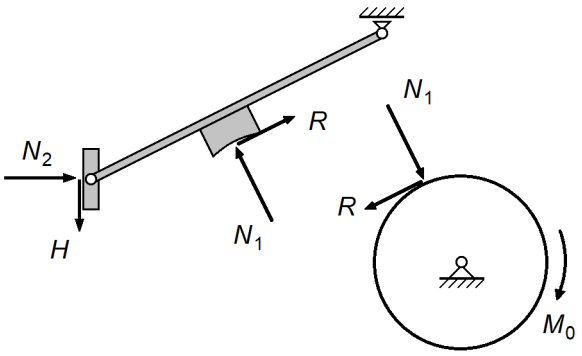
Ergebnisse (ohne Gewähr)

Aufgabe 1-M / Teil 1:

a) System Rad:

$$R\,r = M_0 \quad \Rightarrow \quad R = \frac{M_0}{r} = \frac{400}{\sqrt{3}}\,\mathrm{N}$$

$$N_1 = \frac{R}{\mu} = 800\,\mathrm{N}$$



b) System Bremshebel:

$$N_2 + R\,\cos(\alpha) - N_1\,\sin(\alpha) = 0$$

$$\Rightarrow \quad N_2 = N_1\,\sin(\alpha) - R\,\cos(\alpha) = 200\,\mathrm{N}$$

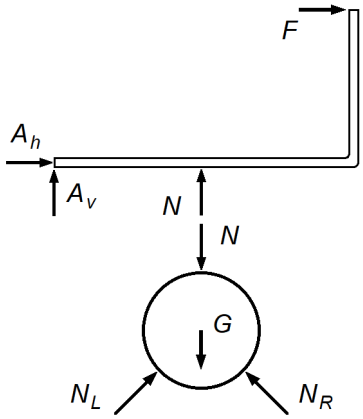
$$N_2\,(a+b)\sin(\alpha) + H\,(a+b)\cos(\alpha) + R\,c - N_1\,b = 0$$

$$\Rightarrow \quad H = \frac{N_1\,b - R\,c}{(a+b)\cos(\alpha)} - N_2\,\tan(\alpha) \approx 438,8\,\mathrm{N}$$

c) $H \le \mu_0\,N_2 \quad \Rightarrow \quad \mu_0 \ge \dfrac{H}{N_2} \approx 2,2$

Aufgabe 1-M / Teil 2:

a)



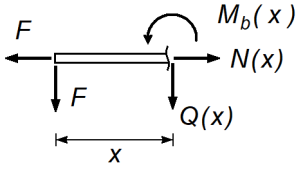
$$-F\,a + N\,a = 0 \quad \Rightarrow \quad N = F$$

$$A_v = -N = -F \quad , \quad A_h = -F$$

$$N_L = N_R = \frac{N+G}{2\,\cos(\alpha)}$$

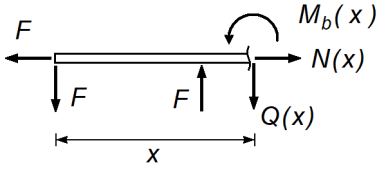
b) $0 < x < a$:

$$N(x) = F$$
$$Q(x) = -F$$
$$M_b(x) = -F\,x$$

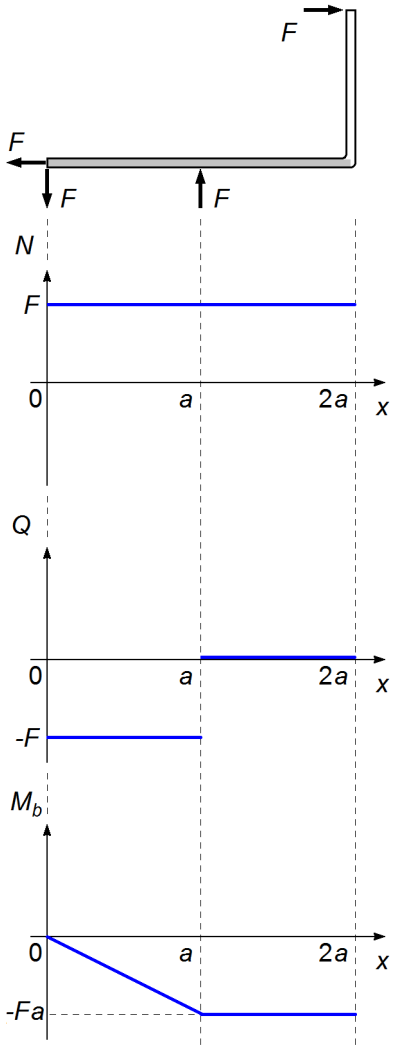


$a < x < 2\,a$:

$$N(x) = F$$
$$Q(x) = 0$$
$$M_b(x) = -F\,a$$



c)



Aufgabe 2-M / Teil 1:

a) $\vec{r}_W(t) = \begin{pmatrix} v_0\, t \\ h_0 \left[1 - \sin\left(\pi\, v_0\, t/(2\, x_0)\right)\right] \end{pmatrix}$

b) $\vec{v}_W(t) = \dot{\vec{r}}_W(t) = \begin{pmatrix} v_0 \\ -h_0 \dfrac{\pi\, v_0}{2\, x_0} \cos\left(\pi\, v_0\, t/(2\, x_0)\right) \end{pmatrix}$

$\vec{a}_W(t) = \dot{\vec{v}}_W(t) = \begin{pmatrix} 0 \\ h_0 \left(\dfrac{\pi\, v_0}{2\, x_0}\right)^2 \sin\left(\pi\, v_0\, t/(2\, x_0)\right) \end{pmatrix}$

c) $v_0\, t_M = 3\, x_0$

$\vec{v}_W(t_M) = \begin{pmatrix} v_0 \\ -h_0 \dfrac{\pi\, v_0}{2\, x_0} \cos(3\,\pi/2) \end{pmatrix} = \begin{pmatrix} v_0 \\ 0 \end{pmatrix} = \begin{pmatrix} 7,5 \\ 0 \end{pmatrix} \mathrm{m\,s^{-1}}$

$\vec{a}_W(t_M) = \begin{pmatrix} 0 \\ h_0 \left(\dfrac{\pi\, v_0}{2\, x_0}\right)^2 \sin(3\,\pi/2) \end{pmatrix} = \begin{pmatrix} 0 \\ -h_0 \left(\dfrac{\pi\, v_0}{2\, x_0}\right)^2 \end{pmatrix} \approx \begin{pmatrix} 0 \\ -13,88 \end{pmatrix} \mathrm{m\,s^{-2}}$

d) $t_E = \dfrac{4\, x_0}{v_0} \approx 5,33\,\mathrm{s}$

$\vec{v}_W(t_E) = \begin{pmatrix} v_0 \\ -h_0 \dfrac{\pi\, v_0}{2\, x_0} \cos(2\,\pi) \end{pmatrix} = \begin{pmatrix} v_0 \\ -h_0 \dfrac{\pi\, v_0}{2\, x_0} \end{pmatrix} \approx \begin{pmatrix} 7,5 \\ -11,78 \end{pmatrix} \mathrm{m\,s^{-1}}$

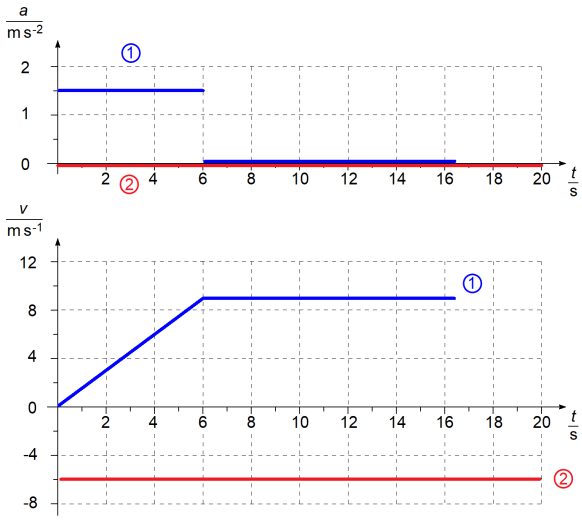
$|\vec{v}_W(t_E)| \approx 13,97\,\mathrm{m\,s^{-1}}$

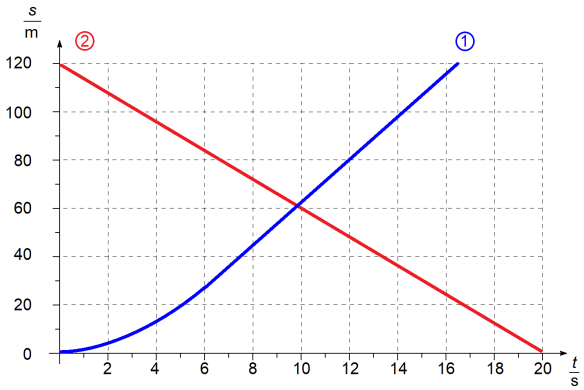
Aufgabe 2-M / Teil 2:

a) $s_1(t) = \begin{cases} a_1\, t^2/2\,, & 0 < t < t_1 \\ v_1\,(t - t_1) + s_1\,, & t > t_1 \end{cases}$, $v_1 = a_1\, t_1 = 9\,\mathrm{m\,s^{-1}}$, $s_1 = \dfrac{1}{2}\, a_1\, t_1^2 = 27\,\mathrm{m}$

$s_2(t) = l - v_2\, t$, $v_2 = 6\,\mathrm{m\,s^{-1}}$

b)





c) $s_1(t_B) = s_2(t_B)$ *für* $t_B > t_1$ $\Rightarrow$ $v_1\,(t_B - t_1) + s_1 = l - v_2\, t_B$

$\Rightarrow$ $t_B = \dfrac{l + v_1\, t_1 - s_1}{v_1 + v_2} = 9,8\,\mathrm{s}$ $\Rightarrow$ $s_B = s_2(t_B) = l - v_2\, t_B = 61,2\,\mathrm{m}$

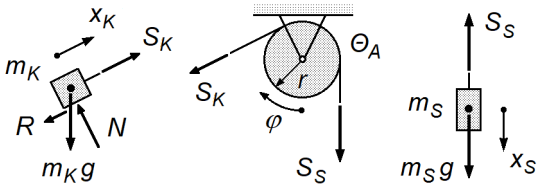
Aufgabe 3-M / Teil 1:

a) $m_K \ddot{x}_K = -R - m_K\, g\, \sin(\alpha) + S_K \qquad (1)$

$0 = N - m_K\, g\, \cos(\alpha)$

$m_S \ddot{x}_S = m_S\, g - S_S \qquad (2)$

$\Theta_A \ddot{\varphi} = S_S\, r - S_K\, r \qquad (3)$



b) *(1) + (2) + (3)/r mit* $R = \mu N = \mu\, m_K\, g\, \cos(\alpha)$ *und* $\varphi = x_S/r$, $x_K = x_S$ *:*

$$\left(m_K + m_S + \frac{\Theta_A}{r^2}\right)\ddot{x}_S = \Big(m_S - m_K\,(\mu\,\cos(\alpha) + \sin(\alpha))\Big)\,g$$

$$\Rightarrow \quad a_S = \ddot{x}_S = \frac{m_S - m_K\,(\mu\,\cos(\alpha) + \sin(\alpha))}{m_K + m_S + \Theta_A/r^2}\,g$$

c) $m_S \geq m_K\,(\mu\,\cos(\alpha) + \sin(\alpha)) \approx 1,35\,\text{kg}$

d) $a_S \approx 1,31\,\text{m}\,\text{s}^{-2}$

$$\Rightarrow \quad S_S = m_S\,(g - a_S) \approx 17,39\,\text{N}$$

$$\Rightarrow \quad S_K = m_K\left(a_S + (\mu\,\cos(\alpha) + \sin(\alpha))\,g\right) = S_S - \frac{\Theta_A}{r^2}\,a_S \approx 16,08\,\text{N}$$

Aufgabe 3-M / Teil 2:

a) $\varphi = \dfrac{x}{r_I} \quad , \quad s = \dfrac{r_A}{r_I}\,x$

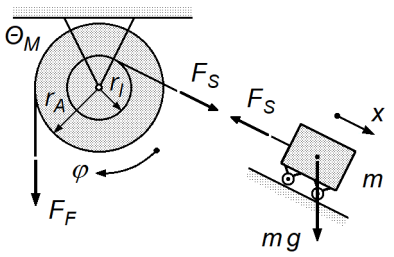
b) $m \ddot{x} = m\,g\,\sin(\alpha) - F_S \qquad (1)$

$\Theta_M \ddot{\varphi} = F_S\, r_I - F_F\, r_A \qquad (2)$

(1) + (2)/r_I *mit* $F_F = c\,s$ *und a):*

$$\left(m + \frac{\Theta_M}{r_I^2}\right)\ddot{x} = m\,g\,\sin(\alpha) - c\left(\frac{r_A}{r_I}\right)^2 x$$

$$\Rightarrow \quad \ddot{x} + \frac{c\,(r_A/r_I)^2}{m + \Theta_M/r_I^2}\,x = \frac{m\,g\,\sin(\alpha)}{m + \Theta_M/r_I^2}$$



c) $\omega^2 = \dfrac{c\,(r_A/r_I)^2}{m + \Theta_M/r_I^2} = \dfrac{4\,\pi^2}{T^2}$

$$\Rightarrow \quad \Theta_M = r_I^2\left(\frac{c\,T^2\,(r_A/r_I)^2}{4\,\pi^2} - m\right) \approx 0,0813\,\text{kg}\,\text{m}^2$$

Aufgabe 4-E / Teil 1:

b)

$$E_1 = \frac{|Q_1|}{4\,\pi\,\varepsilon_0\,r_1^2}\ , \quad r_1 = \sqrt{2}\,a \approx 7,07\,\text{cm}$$

$$\Rightarrow \quad E_1 \approx 3596\,\text{N}\,\text{C}^{-1}$$

$$E_2 = \frac{|Q_2|}{4\,\pi\,\varepsilon_0\,r_2^2}\ , \quad r_2 = 2\,a = 10\,\text{cm}$$

$$\Rightarrow \quad E_2 \approx 7193\,\text{N}\,\text{C}^{-1}$$

$$E_3 = \frac{|Q_3|}{4\,\pi\,\varepsilon_0\,r_3^2}\ , \quad r_3 = \sqrt{2}\,a \approx 7,07\,\text{cm}$$

$$\Rightarrow \quad E_3 \approx 1798\,\text{N}\,\text{C}^{-1}$$

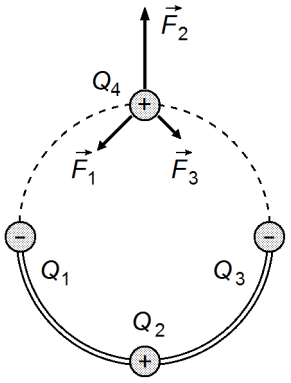
$$\vec{F}_1 = Q_4\,\vec{E}_1 = \begin{pmatrix} -Q_4\,E_1\,\cos(45°) \\ -Q_4\,E_1\,\sin(45°) \end{pmatrix} \approx \begin{pmatrix} -2,54 \\ -2,54 \end{pmatrix}\text{mN}$$

$$\vec{F}_2 = Q_4\,\vec{E}_2 = \begin{pmatrix} 0 \\ Q_4\,E_2 \end{pmatrix} \approx \begin{pmatrix} 0 \\ 7,19 \end{pmatrix}\text{mN}$$

$$\vec{F}_3 = Q_4\,\vec{E}_3 = \begin{pmatrix} E_3\,\cos(45°) \\ -E_3\,\sin(45°) \end{pmatrix} \approx \begin{pmatrix} 1,27 \\ -1,27 \end{pmatrix}\text{mN}$$

$$\Rightarrow \quad \vec{F}_{res} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = \begin{pmatrix} -1,27 \\ 3,38 \end{pmatrix}\text{mN}$$

a)

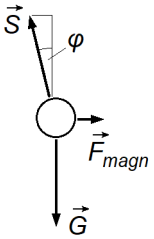


Aufgabe 4-E / Teil 2:

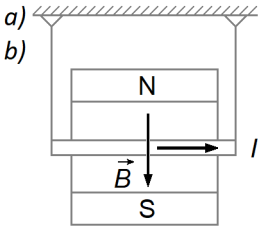
c) $S_x = F_{magn} = I\,b\,B \quad , \quad S_y = G = m\,g$

$$\frac{S_x}{S_y} = \tan(\varphi) = \frac{I\,b\,B}{m\,g}$$

$$\Rightarrow \quad B = \frac{m\,g\,\tan(\varphi)}{I\,b} \approx 0,04\,\text{T}$$

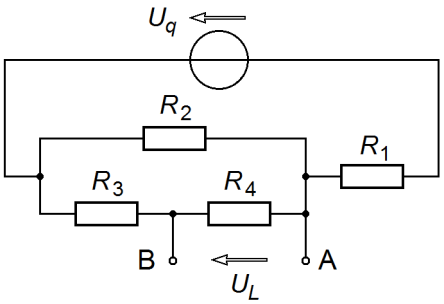


a)
b)



Aufgabe 5-E / Teil 1:

a)



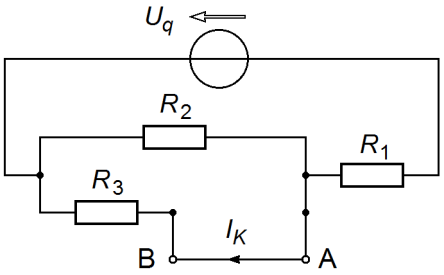
$$R_{1234} = R_1 + R_{234} = R_1 + \frac{R_2\,(R_3 + R_4)}{R_2 + R_3 + R_4} = 25\,\Omega$$

$$U_L = U_{AB} = U_4 = \frac{R_3}{R_3 + R_4}\,U_{34}$$

$$= \frac{R_3}{R_3 + R_4}\,(U_q - U_1) = \frac{R_3}{R_3 + R_4}\,(U_q - I_1\,R_1)$$

$$= \frac{R_3}{R_3 + R_4}\,U_q\left(1 - \frac{R_1}{R_{1234}}\right) = 7,2\,\mathrm{V}$$

b) Variante 1: Zuerst I_K , dann R_i



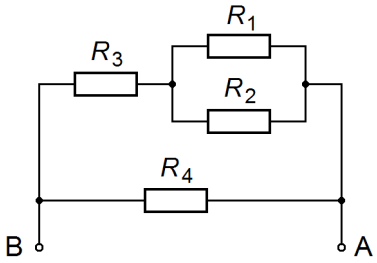
$$R_{123} = R_1 + \frac{R_2\,R_3}{R_2 + R_3} = 22\,\Omega$$

$$I_K = I_3 = \frac{U_3}{R_3} = \frac{1}{R_3}\,(U_q - U_1)$$

$$= \frac{1}{R_3}\,(U_q - I_1\,R_1) = \frac{U_q}{R_3}\left(1 - \frac{R_1}{R_{123}}\right) \approx 0,436\,\mathrm{A}$$

$$\Rightarrow \quad R_i = \frac{U_L}{I_K} = 16,5\,\Omega$$

Variante 2: Zuerst R_i , dann I_K



$$R_i = R_{1234} = \frac{R_4\,R_{123}}{R_4 + R_{123}} = \frac{R_4\left(R_3 + \dfrac{R_1\,R_2}{R_1 + R_2}\right)}{R_4 + R_3 + \dfrac{R_1\,R_2}{R_1 + R_2}}$$

$$= 16,5\,\Omega$$

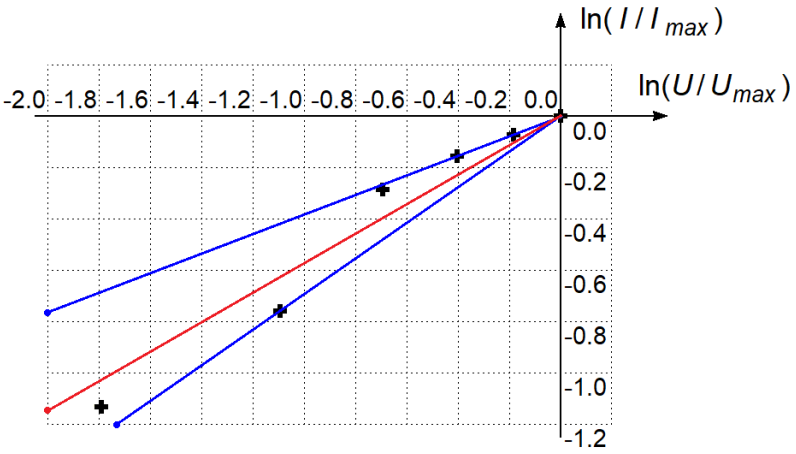
$$\Rightarrow \quad I_K = \frac{U_L}{R_i} \approx 0,436\,\mathrm{A}$$

Aufgabe 5-E / Teil 2:

a)

U/V	4	8	12	16	20	24
$\ln(U/U_{max})$	- 1,792	- 1,098	- 0,693	- 0,405	- 0,182	0,000
I/A	0,09	0,16	0,21	0,24	0,26	0,28
$\ln(I/I_{max})$	- 1,135	-0,560	-0,288	-0,154	- 0,074	0,000

$$\ln\left(\frac{I}{I_{max}}\right) = k\left(\frac{U}{U_{max}}\right)$$



b) $$k = \frac{-1,14}{-2,0} = 0,57$$

c) $$k_{min} = \frac{-0,76}{-2,0} = 0,38$$

$$k_{max} = \frac{-1,2}{-1,74} = 0,69$$

$$\Rightarrow \quad (\Delta k)_{max} = 0,19$$

Aufgabe 6-E / Teil 1:

a) $i_0 = \dfrac{U_q}{R_1 + R_2} = 0,36\,\mathrm{A}$

b) $i_\infty = \dfrac{U_q}{R_2} = 0,6\,\mathrm{A}$

c) $i(t) = i_1(t) + i_L(t) \quad , \quad u_L(t) + u_2(t) = U_q \quad , \quad u_1(t) + u_2(t) = U_q$

$u_1(t) = R_1\, i_1(t) \quad , \quad u_2(t) = R_2\, i(t) \quad , \quad u_L(t) = L\, \dot{i}_L(t)$

$\Rightarrow \quad L\, \dot{i}_L(t) + R_2\, i(t) = U_q \quad , \quad \dot{i}_L(t) = \dot{i}(t) - \dot{i}_1(t) \quad , \quad R_1\, \dot{i}_1(t) + R_2\, \dot{i}(t) = 0$

$\Rightarrow \quad L\left(1 + \dfrac{R_2}{R_1}\right) \dot{i}(t) + R_2\, i(t) = U_q \quad \textit{oder} \quad L\left(\dfrac{1}{R_2} + \dfrac{1}{R_1}\right) \dot{i}(t) + i(t) = \dfrac{U_q}{R_2}$

$\Rightarrow \quad T = L\left(\dfrac{1}{R_2} + \dfrac{1}{R_1}\right) = 0,5\,\mathrm{s}$

Aufgabe 6-E / Teil 2:

a) $u(t) = \dfrac{U_{max}}{T}\, t$

b) $u_m = U_{max}/2$

$u_{eff}^2 = \dfrac{1}{T} \displaystyle\int_0^T u^2(t)\,\mathrm{d}t = \frac{U_{max}^2}{T^3} \int_0^T t^2\,\mathrm{d}t = \frac{U_{max}^2}{3} \quad \Rightarrow \quad u_{eff} = \dfrac{U_{max}}{\sqrt{3}}$

c) $\hat{u}_L = 2\,\pi\, f\, L\, \hat{\imath} \approx 5,0\,\mathrm{V} \quad , \quad \hat{u}_C = \dfrac{1}{2\,\pi\, f\, C}\, \hat{\imath} \approx 2,0\,\mathrm{V} \quad , \quad \hat{u} = \hat{u}_L - \hat{u}_C \approx 3,0\,\mathrm{V}$

d)