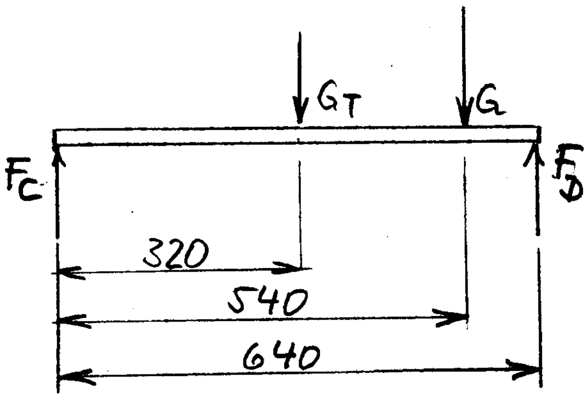
Aufgabe 1

1. Tischplatte freigemacht:



$\circlearrowleft C$: $F_D \cdot 640 - G_T \cdot 320 - G \cdot 540 = 0$

$\rightsquigarrow F_D = \frac{1}{640}(G_T \cdot 320 + G \cdot 540)$

$F_D = \frac{1}{640}(100 \cdot 320 + 400 \cdot 540)$

$F_D = 387{,}5\,N$

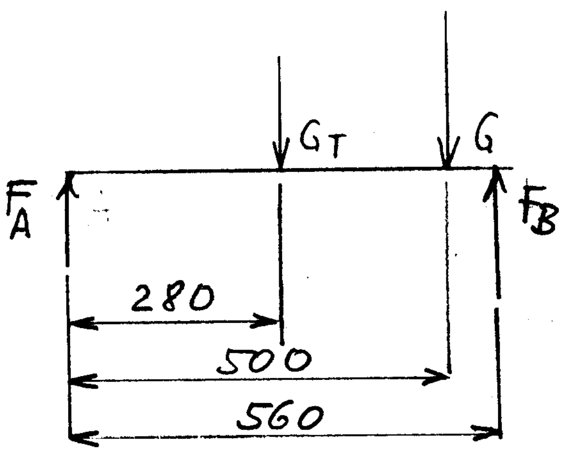
$\circlearrowleft D$: $-F_C \cdot 640 + G_T \cdot 320 + G \cdot 100 = 0$

$\rightsquigarrow F_C = \frac{1}{640}(G_T \cdot 320 + G \cdot 100) = \frac{1}{640}(100 \cdot 320 + 400 \cdot 100)$

$F_C = 112{,}5\,N$

Kontrolle: $\uparrow F_C - G_T - G + F_D = 112{,}5 - 100 - 400 + 387{,}5 = 0$

Gesamter Tisch bei A und B freigemacht:



$\circlearrowleft A$: $F_B \cdot 560 - G_T \cdot 280 - G \cdot 500 = 0$

$\rightsquigarrow F_B = \frac{1}{560}(G_T \cdot 280 + G \cdot 500)$

$F_B = \frac{1}{560}(100 \cdot 280 + 400 \cdot 500)$

$F_B \approx 407\,N$

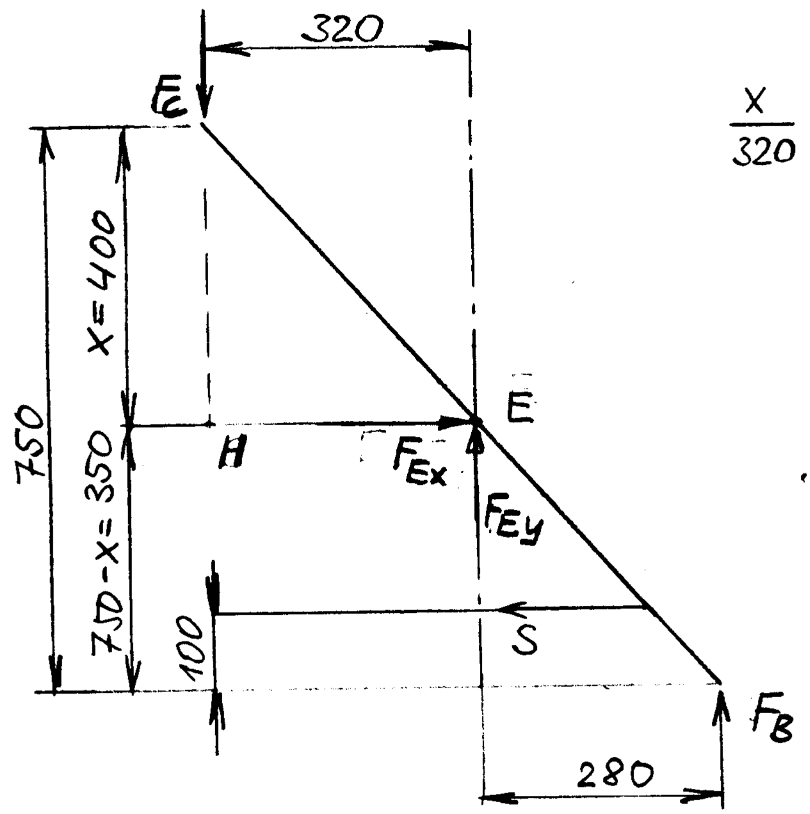
$\circlearrowleft B$: $-F_A \cdot 560 + G_T \cdot 280 + G \cdot 60 = 0$

$\rightsquigarrow F_A = \frac{1}{560}(G_T \cdot 280 + G \cdot 60) = \frac{1}{560}(100 \cdot 280 + 400 \cdot 60)$

$F_A \approx 93\,N$

Kontrolle:

$\uparrow \; 93 - 100 - 400 + 407 = 0$



$$\frac{x}{320} = \frac{750}{600} \rightsquigarrow x = 400$$

$\overset{\curvearrowleft}{E}$ $\quad -S \cdot 250 + F_C \cdot 320 + F_B \cdot 280 = 0$

$$\rightsquigarrow S = \frac{1}{250}(F_C \cdot 320 + F_B \cdot 280) = \frac{1}{250}(112{,}5 \cdot 320 + 407 \cdot 280)$$

$$S = 600\ \text{N}$$

$\overset{\curvearrowleft}{H}$ $\quad F_{Ey} \cdot 320 - S \cdot 250 + F_B \cdot 600 = 0$

$$\rightsquigarrow F_{Ey} = \frac{1}{320}(S \cdot 250 - F_B \cdot 600) = \frac{1}{320}(600 \cdot 250 - 407 \cdot 600)$$

$$F_{Ey} \approx -295\ \text{N}$$

$\rightarrow \quad F_{Ex} - S = 0 \rightsquigarrow E_x = S = 600\ \text{N}$

Kontrolle:

$\uparrow \quad -F_C + E_y + F_B = -113 - 295 + 407 = 0$

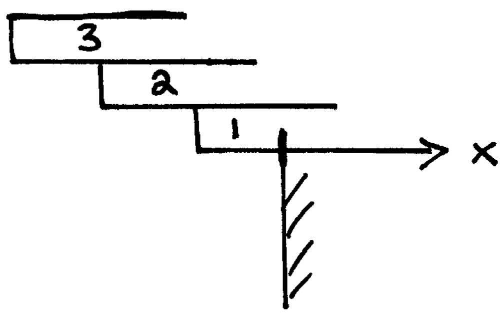
$$F_E = \sqrt{F_{Ex}^2 + F_{Ey}^2} = \sqrt{600^2 + 295^2} \approx 668\ \text{N}$$

$$\alpha = \arctan \frac{F_{Ey}}{F_{Ex}} = \arctan \frac{-295}{600} \approx -26°$$

Aufgabe 2

Schwerpunkt

$$x_S = \frac{1}{G_{ges}} \sum x_{Si} \cdot G_i$$



x zählt ab der Kante nach rechts

Der Schwerpunkt von jedem Brett liegt in der Mitte bei $L/2$

$$x_{S1} = \frac{L}{2} - \frac{L}{6} = \frac{2}{6}L$$

$$x_{S2} = \frac{L}{2} - \frac{2}{6}L = \frac{1}{6}L$$

$$x_{S3} = \frac{L}{2} - \frac{3}{6}L = 0$$

Der Schwerpunkt der Person liegt bei

$$x_P = \frac{5}{6}L - a$$

$x_S \geq 0$ damit alles in Ruhe bleibt.

<u>Grenzfall</u>: $x_S = 0$

$$0 = \frac{1}{G_{ges}} \left[G \cdot L \left(\frac{2}{6} + \frac{1}{6} + 0 \right) + G_P \left(\frac{5}{6}L - a \right) \right]$$

$$\frac{1}{2}\cancel{G}L + \frac{3}{2}\cancel{G} \cdot \frac{5}{6}L = \frac{3}{2}\cancel{G} \cdot a$$

$$\frac{1}{2}L + \frac{5}{4}L = \frac{7}{4}L = \frac{3}{2}a \qquad a = \frac{7}{4} \cdot \frac{2}{3}L \qquad \underline{\underline{a = \frac{7}{6}L}}$$

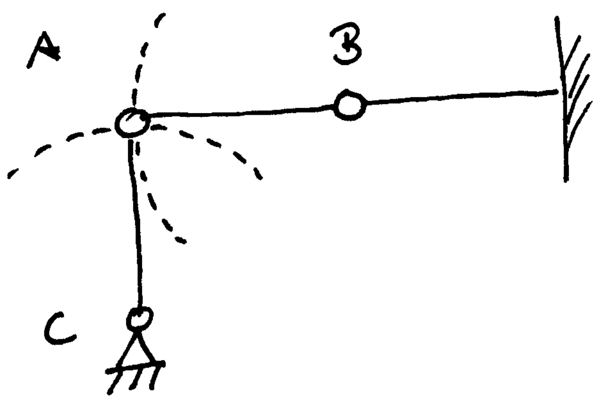
Aufgabe 3

a) • 3 Teile in der Ebene mit je 3 Freiheitsgraden $\Rightarrow$ 9 Freiheitsgrade

• 3 zweiwertige Lager und 1 dreiwertiges Lager $\Rightarrow$ 9 Lagerreaktionen

$\Rightarrow$ notwendige Bedingung der stat. Bestimmten Lagerung erfüllt!

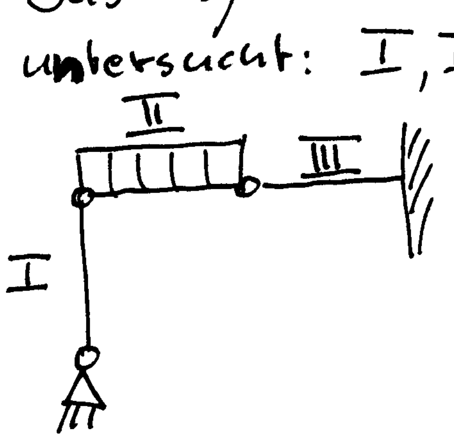
Hinreichende Bedingung:



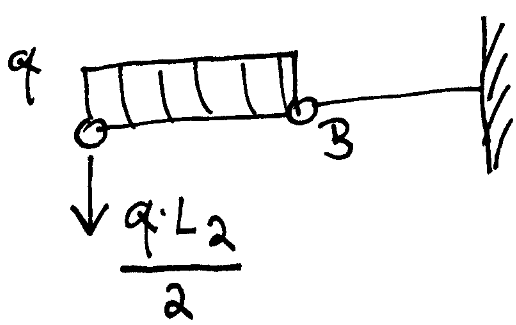
• Punkt B ist in seiner Lage definiert.

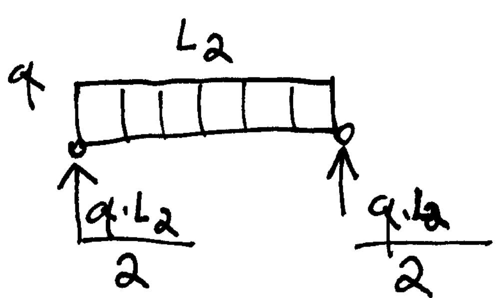
• Eine Bewegung von A muß auf einer Kreis= bahn um B und C stattfinden. Dabei gibt es für A nur eine Möglichkeit zur Positionierung.

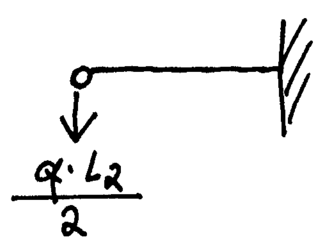
b) Das System wird in drei Teilen untersucht: I, II, III



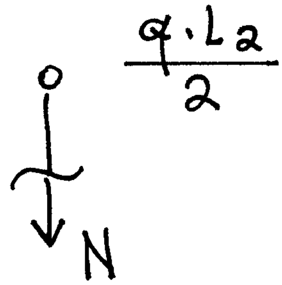
teilweise freischneiden







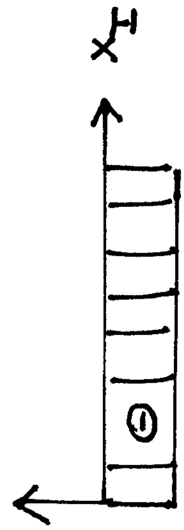
I)



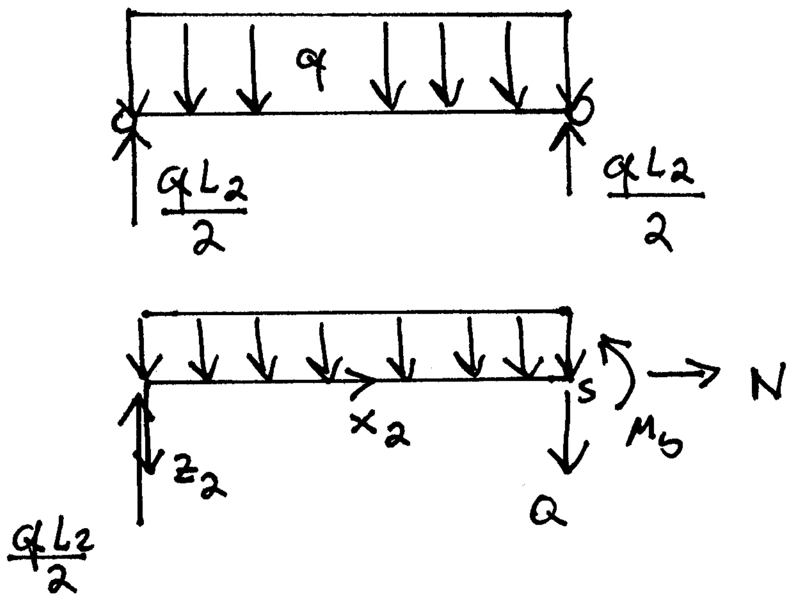
$$N = -\frac{q \cdot L_2}{2}$$

$$Q = 0$$

$$M_b = 0$$



II)

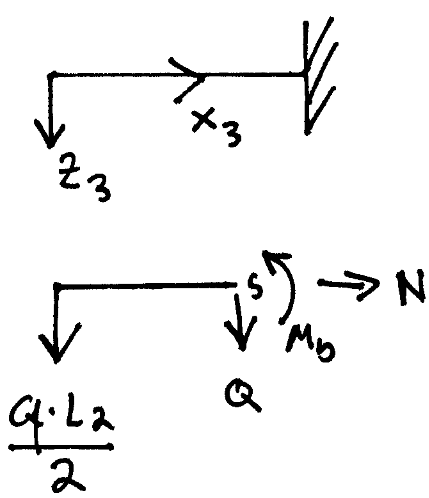


$$N = 0$$

$$(\downarrow) \quad Q + q \cdot x_2 - \frac{q \cdot L_2}{2} = 0 \qquad Q = -q \cdot x_2 + \frac{q \cdot L_2}{2}$$

$$(\curvearrowleft_s) \quad M_b + \frac{q \cdot x_2^2}{2} - \frac{q \cdot L_2 \cdot x_2}{2} = 0 \qquad M_b = -\frac{q \cdot x_2^2}{2} + \frac{q \cdot L_2 \cdot x_2}{2}$$

III)



$$N = 0$$

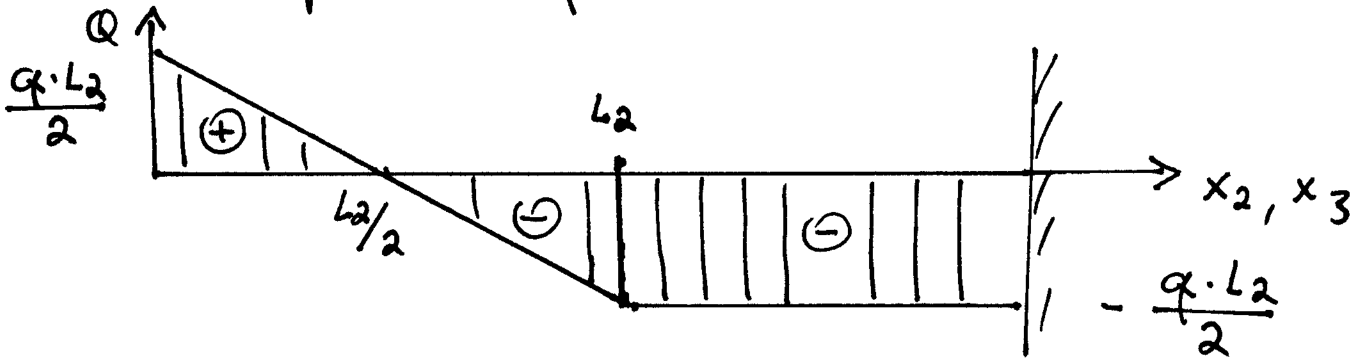
$$(\downarrow) \quad Q + \frac{q \cdot L_2}{2} = 0$$

$$Q = -\frac{q \cdot L_2}{2}$$

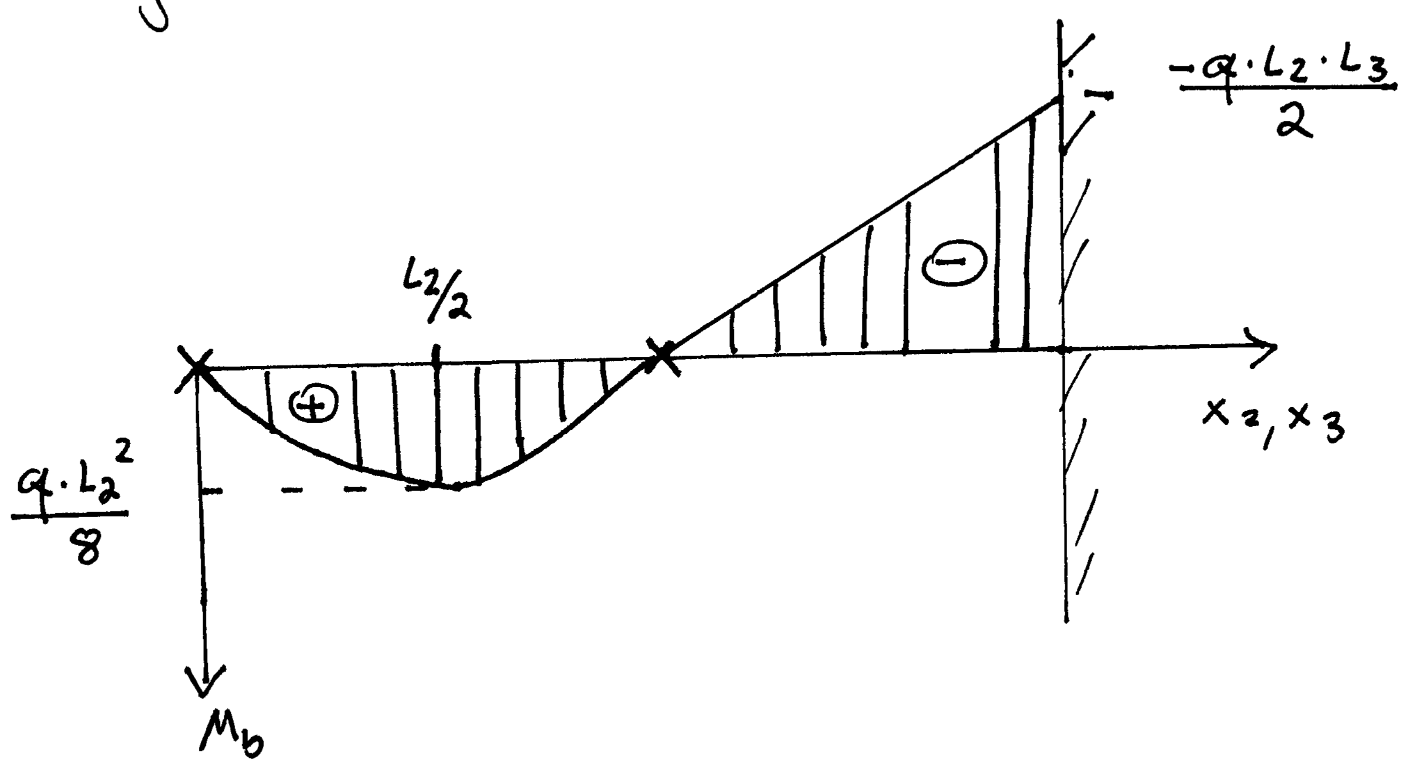
(ΣM_S) $M_b + \frac{q \cdot L_2}{2} \cdot x_3 = 0$

$$M_b = -\frac{q \cdot L_2}{2} \cdot x_3$$

Querkraftverlauf über $\underline{II}$ und $\underline{III}$:



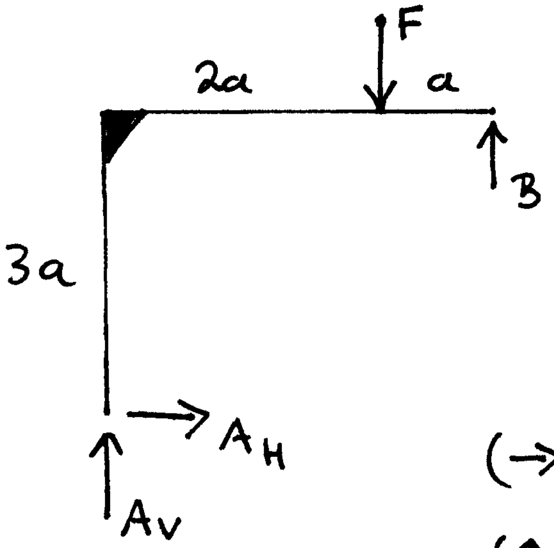
Biegemomentenverlauf über $\underline{II}$ und $\underline{III}$:



Aufgabe 4

a) Nullstäbe sind die Stäbe 3, 7, 8

b)



$(\curvearrowleft A)$

$$3aB - 2aF = 0$$

$$B = \tfrac{2}{3}F$$

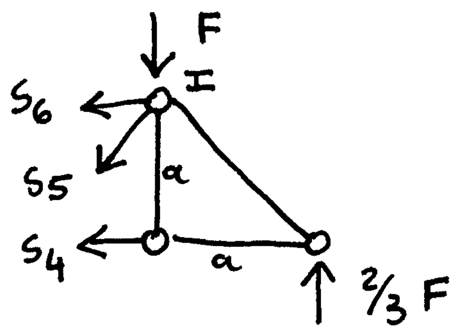
$(\rightarrow)$ $A_H = 0$

$(\uparrow)$ $A_V + B - F = 0$

$$A_V = F - B$$

$$A_V = \tfrac{1}{3}F$$

c) RITTER-Schnitt



$(\curvearrowleft I)$ $-S_4 \cdot a + \frac{2}{3}Fa = 0$ $\qquad S_4 = \frac{2}{3}F$

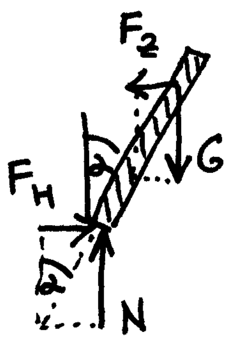
$(\uparrow)$ $-\frac{1}{2}\sqrt{2}\,S_5 - F + \frac{2}{3}F = 0$

$-\frac{1}{2}\sqrt{2}\,S_5 = \frac{1}{3}F$ $\qquad S_5 = -\frac{\sqrt{2}}{3}F$

$(\rightarrow)$ $-S_4 - S_6 - \frac{1}{2}\sqrt{2}\,S_5 = 0$

$-\frac{2}{3}F + \frac{1}{2}\sqrt{2} \cdot \frac{\sqrt{2}}{3}F = S_6$ $\qquad S_6 = -\frac{1}{3}F$

Aufgabe 5



$$\tan \alpha = \frac{F_H}{N}$$

$$F_H = \mu_0 \cdot N \qquad N = G$$

Grenzfall

$$\frac{F_H}{N} = \mu_0$$

$$\tan \alpha = \mu_0$$

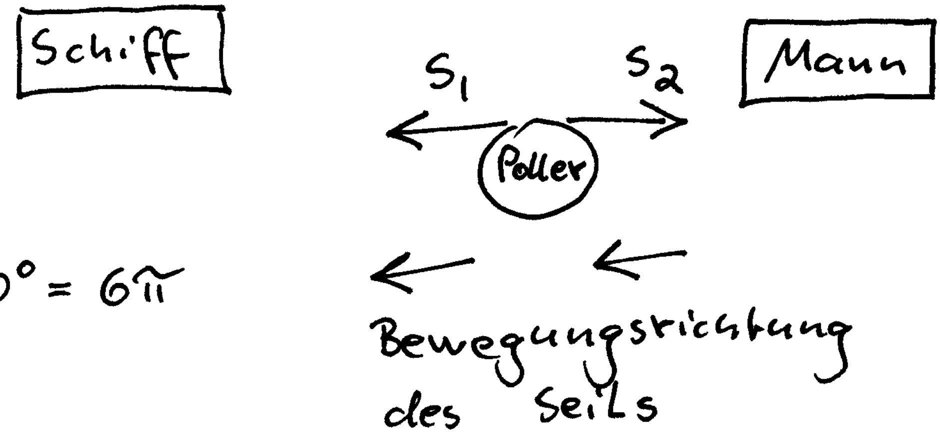
$$\alpha = \arctan \mu_0$$

a) $\alpha = 31.0^\circ$

b) $\alpha = 11.3^\circ$

Aufgabe 6

a) Seilreibung



$\alpha = 1080° = 6\pi$

$$S_1 = S_2 \cdot e^{\mu\alpha} = 100\,N \cdot e^{0.3 \cdot 6\pi} = 28568\,N$$

b) $W = E = F \cdot s$ hier: $E = S_1 \cdot s$

$$\overset{!}{=} 28568\,N \cdot 2\,m$$

$$\overset{!}{=} 57136\,Nm = 57136\,J$$

c) $E_{kin} = \frac{1}{2} m v^2$ $v = 1\,m/s$

$$E_{kin} = \underline{E} = \frac{1}{2} m v^2$$

aus b)

$$m = \frac{2E}{v^2} = \frac{2 \cdot 57136\,\cancel{Nm} \cdot \cancel{s^2} \cdot kg \cdot \cancel{m}}{1^2\,\cancel{m^2} \cdot \cancel{s^2}}$$

$$= 114{,}3\,t$$