# Klassische Physik 1 Hausaufgaben Blatt Nr. 1

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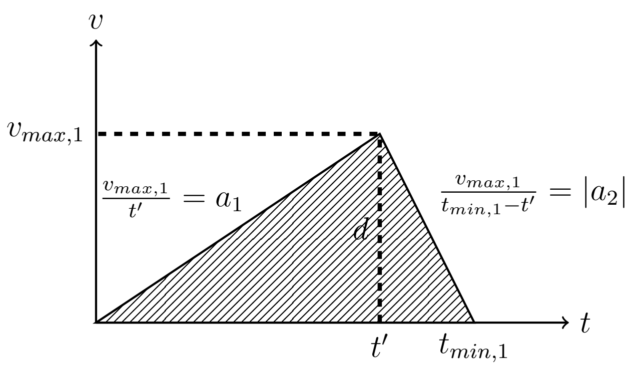
**Aufgabe 1.1**

(a)




Man löst die Gleichungen

$$\frac{1}{2}(v_{max,1})(t_{min,1}) = d \tag{1}$$

$$v_{max,1} = a_1 t' \tag{2}$$

$$v_{max,1} = (t' - t_{min,1})a_2 \tag{3}$$

Aus (2) folgt $t' = v_{max,1}/a_1$. Wir setzen das in (3) ein. Es ergibt sich

$$v_{max,1} = \left(\frac{v_{max,1}}{a_1} - t_{min,1}\right) a_2.$$

Daraus folgt:

$$v_{max,1}\left(1 - \frac{a_2}{a_1}\right) = -t_{min,1}a_2.$$

(b) Noch einmal setzen wir das in (1) ein:

$$\frac{1}{2}\left[-t_{min,1}a_2\left(1 - \frac{a_2}{a_1}\right)^{-1}\right](t_{min,1}) = d.$$

Die Lösung ist

$$t_{min,1} = \boxed{\left[-\frac{2d}{a_2}\left(1 - \frac{a_2}{a_1}\right)\right]^{1/2}}.$$

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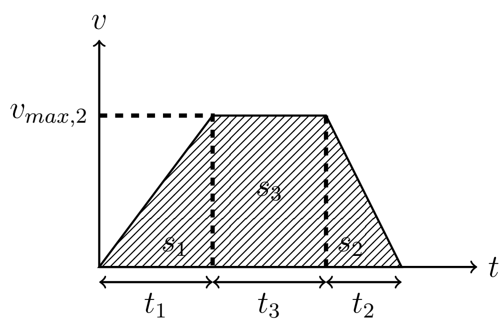
Aus (1) folgt

$$v_{max,1} = \frac{2d}{t_{mn,1}}.$$

Also

$$v_{max,1} = \boxed{\left[-\frac{1-\frac{a_2}{a_1}}{2a_2 d}\right]^{-1/2}}.$$

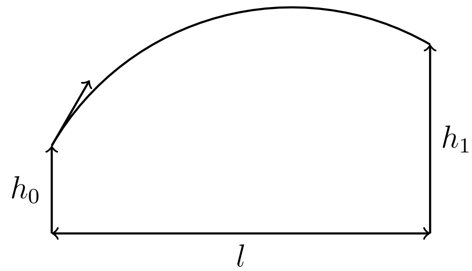



(c)

Es gilt

$$\begin{aligned}
t_1 =& \frac{v_{max,2}}{a_1} \\
t_2 =& -\frac{v_{max,2}}{a_2} \\
s_1 =& \frac{1}{2} a_1 t_1^2 = \frac{v_{max,2}^2}{2a_1} \\
s_2 =& \frac{1}{2} v_{max,2} t_2 = -\frac{v_{max,2}^2}{2a_2} \\
s_3 =& v_{max,2} t_3 = d - s_1 - s_2 \\
t_3 =& \frac{d - s_1 - s_2}{v_{max,2}} \\
=& \frac{d}{v_{max,2}} - \frac{v_{max,2}}{2a_1} + \frac{v_{max,2}}{2a_2} \\
t_{min,2} =& t_1 + t_2 + t_3 \\
=& \frac{d}{v_{max,2}} + \frac{v_{max,2}}{2a_1} - \frac{v_{max,2}}{2a_2}
\end{aligned}$$

**Aufgabe 1.2**



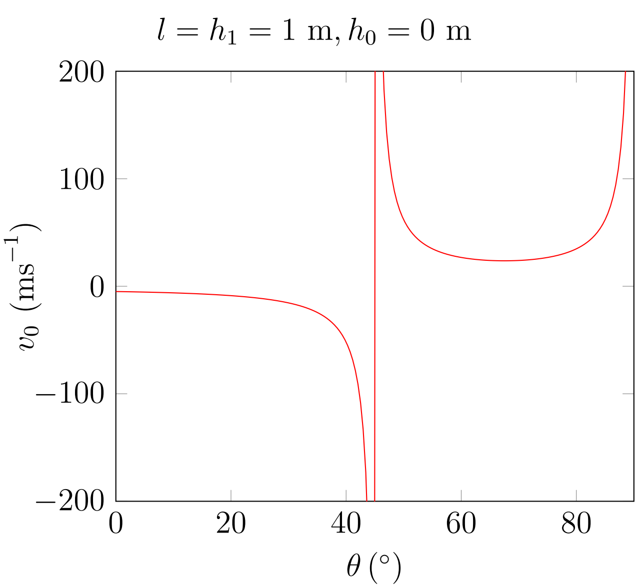

$$x = v_0 t \cos\theta$$
$$y = v_0 t \sin\theta - \frac{1}{2} g t^2$$
$$y = x \tan\theta - \frac{g x^2}{2 v_0^2 \cos^2\theta}$$

Wir brauchen $y(l) = h_1 - h_0$, oder

$$h_1 - h_0 = l \tan\theta - \frac{g l^2}{2 v_0^2 \cos^2\theta}.$$

Daraus folgt

$$v_0^2 = \frac{g l^2}{2\cos^2\theta\,(l\tan\theta - (h_1 - h_0))}.$$




Es folgt daraus:

$$y = x \tan\theta - (l \tan\theta - (h_1 - h_0)) \frac{x^2}{l^2}.$$

(b) Sei $\varphi$ der Eintreffwinkel des Balls, und $\varphi'$ der Winkel des Balls beim Überfliegen des Korbrandes. Es gilt dann $\varphi \approx \varphi'$.

Zudem gilt:

$$\tan\varphi = \frac{U}{d\pi}$$

Die Trajektorie des Balls wird beschrieben durch

$$y(x) = -\frac{g}{2v_0^2\cos^2\alpha}x^2 + \tan\alpha x + h_0.$$

Der Ball passiert den Korbrand an der Stelle $x_R = l - \frac{d}{2}$.

Es gilt

$$y'(x_R) = -\frac{g}{v_0^2 \cdot \cos^2\alpha}x_R + \tan\alpha.$$

Somit lautet die Tangentenfunktion an der Stelle $x_R$

$$t(x_R) = \left(-\frac{g}{v_0^2\cos^2\alpha}x_R + \tan\alpha\right)(x - x_R) - \frac{g}{2v_0^2 \cdot \cos^2\alpha}x_R^2 + \tan\alpha x_R + h_0$$

mit der Steigung

$$m = -\frac{g}{v_0^2\cos^2\alpha}x_R + \tan\alpha.$$

Es gilt dann

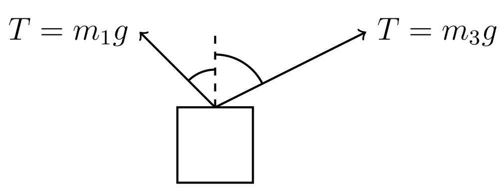
$$m = \tan\varphi = \frac{U}{2\pi}$$

$$-\frac{g}{v_0^2\cos^2\alpha}\left(l - \frac{d}{2}\right) + \tan\alpha = \frac{U}{d\pi}$$

$$\alpha = \arctan\left(\frac{U}{d\pi} + \frac{g}{v_{0,x}^2}\left(l - \frac{d}{2}\right)\right).$$

Der Winkel $\alpha$ muss also mindestens $\arctan\left(\frac{U}{d\pi} + \frac{g}{v_{0,x}^2}\left(l - \frac{d}{2}\right)\right)$ betragen.

**Aufgabe 1.3**



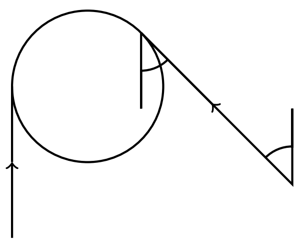

Es gilt

$$x : m_1 g\sin\alpha = m_3 g\sin\beta$$

$$y : m_1 g\cos\alpha + m_3 g\cos\beta = m_2 g$$

Also

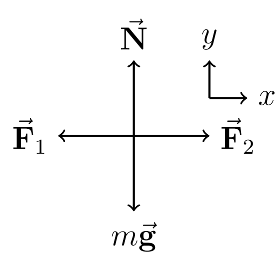
$$\begin{aligned} m_3 =& m_1 \frac{\sin\alpha}{\sin\beta} \\ m_1\cos\alpha + m_1 \frac{\sin\alpha}{\sin\beta}\cos\beta =& m_2 \\ m_1 =& \frac{m_2}{\cos\alpha + \cos\beta\left(\frac{\sin\alpha}{\sin\beta}\right)} \\ =& \frac{m_2 \sin\beta}{\sin(\alpha+\beta)} \\ m_3 =& \frac{m_2 \sin\alpha}{\sin(\alpha+\beta)} \end{aligned}$$



$$\begin{aligned} \vec{\mathbf{F}} =& -\left[\begin{pmatrix} 0 \\ -m_1 g \end{pmatrix} + m_1 g \begin{pmatrix} \sin\alpha \\ -\cos\alpha \end{pmatrix}\right] \\ =& m_1 g \begin{pmatrix} -\sin\alpha \\ 1+\cos\alpha \end{pmatrix} \end{aligned}$$

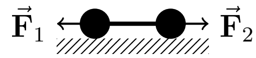
### Aufgabe 1.4

(a)



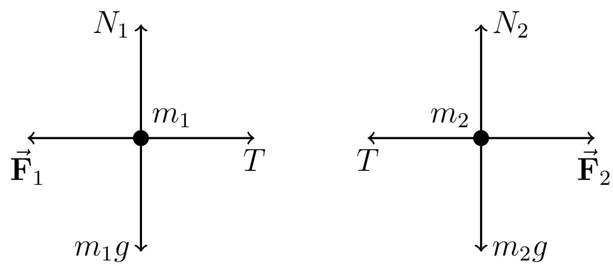

(b) $a_y = 0$ (Zwangsbedingung), $a_x = \frac{1}{3m}\left(|F_2| - |F_1|\right)$

(c)




$$a_1 = a_2 = \frac{1}{3m}\left(|\vec{\mathbf{F}}_2| - |\vec{\mathbf{F}}_1|\right).$$

(d)




(e)

$$\begin{aligned}
m_1 a =& T - F_1 \\
m_2 a =& F_2 - T \\
(m_1 + m_2) a =& T - F_1 + F_2 - T \\
=& F_2 - F_1 \\
=& 3ma \\
a =& \frac{1}{3m}\left(F_2 - F_1\right)
\end{aligned}$$