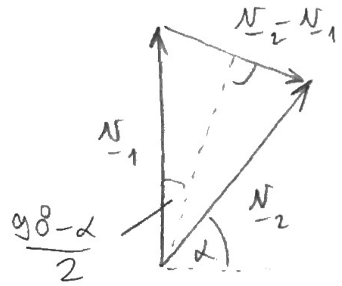
F1.

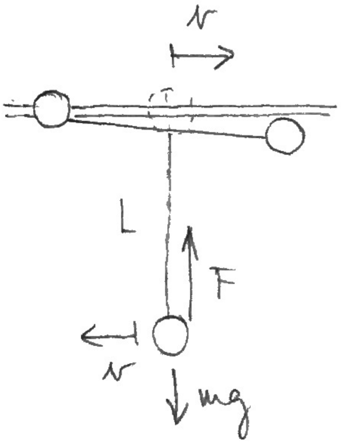
$$\underline{r}_1(t) = \underline{v}_1 t + \frac{1}{2} g t^2$$
$$\underline{r}_2(t) = \underline{v}_2 t + \frac{1}{2} g t^2$$
$$\Delta \underline{r} = \underline{r}_2(t) - \underline{r}_1(t) = (\underline{v}_2 - \underline{v}_1) t$$



$$|\Delta \underline{r}| = |\underline{v}_2 - \underline{v}_1| \cdot t = 2 v_0 \sin\left(\frac{90^\circ - \alpha}{2}\right) \cdot t$$

$|\underline{v}_1| = |\underline{v}_2| = v_0$ $\qquad |\Delta \underline{r}| = 22{,}0$ m.

F2.



Energiamegmaradás:

$$mgL = 2 \cdot \frac{1}{2} m v^2 \rightarrow v = \sqrt{gL}.$$

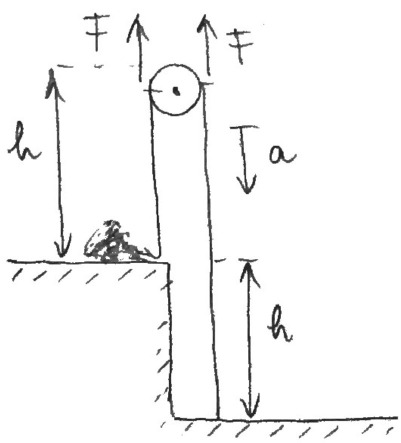
Átülve másik rendszerbe:

$$F - mg = m \frac{(2v)^2}{L},$$

ebből:

$$F = mg + 4mg = 5mg.$$

F3.



Bal oldali rész:

$$F - \lambda g h - \lambda v^2 = \lambda h \cdot a \qquad (1)$$

Jobb oldali rész:

$$\lambda g \cdot 2h - F = \lambda \cdot 2h \cdot a \qquad (2)$$

(1) + (2):

$$gh - v^2 = 3ha,$$

a gyorsulás:

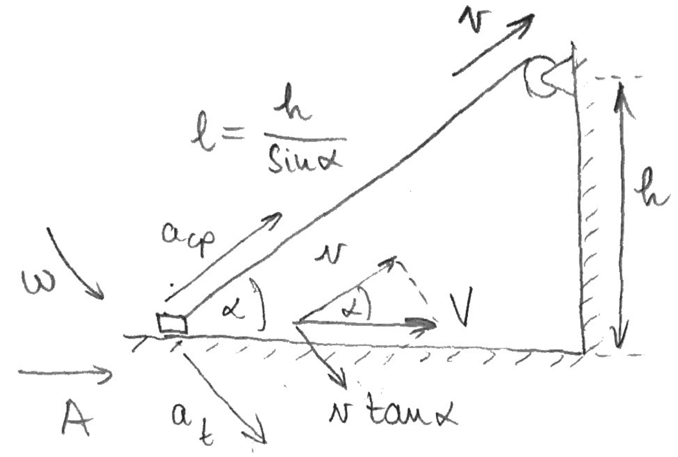
$$a = \frac{1}{3}\left(g - \frac{v^2}{h}\right)$$

a.) Ha $v = 0$, $a = \frac{1}{3} g$.

b.) $a = 0 \rightarrow v = \sqrt{gh}$

c.) $a = \frac{1}{3}\left(g - \frac{1}{4} g\right) = \frac{1}{4} g$.

F4.



a.) $V = \frac{v}{\cos\alpha}$

b.) A fonál felső végével együtt-mozgó rendszerben felírjuk a gyorsulás függőleges komponensének eltűnését:

$$a_{cp}\sin\alpha - a_t\cos\alpha = 0,$$

itt

$$a_{cp} = l\omega^2 = \frac{h}{\sin\alpha}\cdot\frac{v^2\tan^2\alpha}{\left(\frac{h}{\sin\alpha}\right)^2} = \frac{v^2}{h}\cdot\frac{\sin^3\alpha}{\cos^2\alpha}.$$

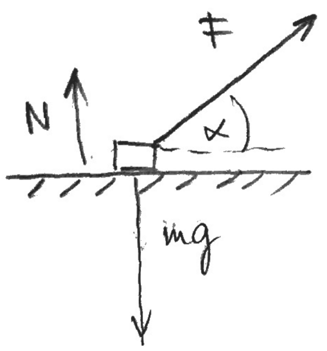
A test gyorsulása:

$$A = a_{cp}\cos\alpha + a_t\sin\alpha = a_{cp}\left(\cos\alpha + \frac{\sin^2\alpha}{\cos\alpha}\right) = a_{cp}\frac{1}{\cos\alpha}.$$

Tehát:

$$A = \frac{v^2}{h}\,\frac{\sin^3\alpha}{\cos^3\alpha} = \frac{v^2}{h}\cdot\tan^3\alpha.$$

c.)



A mozgásegyenletek:

$$\left.\begin{aligned} F\cos\alpha &= mA \\ F\sin\alpha + N - mg &= 0 \end{aligned}\right\} \text{ elváláskor } N = 0.$$

$$\Downarrow$$

$$\cancel{m}g\,\frac{\cos\alpha}{\sin\alpha} = \cancel{m}A = \cancel{m}\frac{v^2}{h}\tan^3\alpha$$

Tehát az elválás szögére:

$$\tan\alpha = \sqrt[4]{\frac{gh}{v^2}}.$$

$$\alpha = \arctan\sqrt[4]{\frac{gh}{v^2}}.$$