F1) $v = 54 \frac{km}{h} = 15 \frac{m}{s}$

$P = 12 kW = 12000 W$

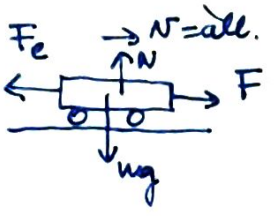
$m = 1000 kg$

a) állandó sebességű vontatás:

$W = P \cdot t = F \cdot s = F \cdot v \cdot t \rightarrow P = Fv \rightarrow$

$\rightarrow F = \frac{P}{v} = 800 N$

b)



$v = áll. \Rightarrow F_e = F = 800 N = \mu \cdot N = \mu mg \rightarrow$

$\rightarrow \mu = \frac{F_e}{mg} = 0{,}08$

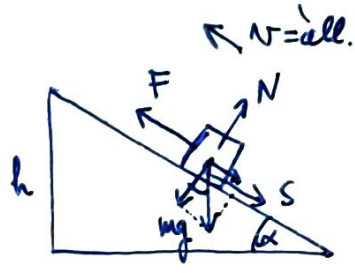
F2) $m = 10 kg$

$h = 8 m$

$\alpha = 15°$

$\mu = 0{,}3$

a)

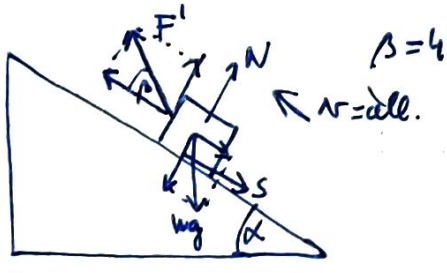


$N = mg\cos\alpha$

$v = áll. \Rightarrow F = S + mg\sin\alpha = \mu mg\cos\alpha + mg\sin\alpha = 55 N$

b) $W_F = F \cdot \frac{h}{\sin\alpha} \approx 1700 J$

c)



$\beta = 45°$

$N + F'\sin\beta = mg\cos\alpha \rightarrow N = mg\cos\alpha - F'\sin\beta$

$F'\cos\beta = S + mg\sin\alpha \quad (*)$

$S = \mu N$

(*):

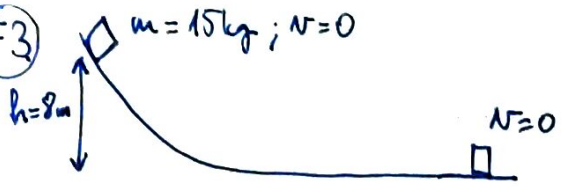
$F'\cos\beta = \mu(mg\cos\alpha - F'\sin\beta) + mg\sin\alpha$

$F'(\cos\beta + \mu\sin\beta) = mg(\mu\cos\alpha + \sin\alpha)$

$F' = mg \cdot \frac{\mu\cos\alpha + \sin\alpha}{\cos\beta + \mu\sin\beta} \approx 60 N > F$

d) $W_{F'} = F'\cos\beta \cdot \frac{h}{\sin\alpha} \approx 1300 J < W_F$

F3



Nem ismerjük a lejtő nagyát, a súrlódási együtthatót (lehet, mindkettő változik is).

Munkatétel!

leeresztés: $W_{grav} + W_{súrl} = \Delta E_{kin} = 0$

$mgh + W_{súrl.} = 0 \rightarrow W_{súrl.} = -mgh$

felhúzás: $W_F + W_{súrl} + W_{grav} = 0$ (lassan húzzuk; $W_{súrl.}$ ugyanaz)

$W_F - mgh - mgh = 0 \rightarrow W_F = 2mgh = 2400\,J$

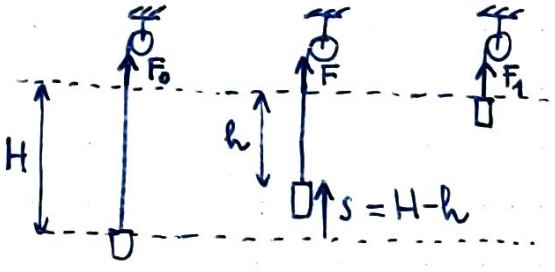
F4.

$H = 8m$

$M = 10kg$ (víz)

$m = 2kg$

$\lambda = 1\,kg/m$



$F_0 = Mg + mg + \lambda Hg = 200N$

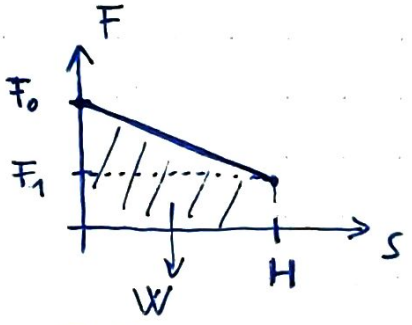
$F_1 = Mg + mg = 120N$

$F(h) = Mg + mg + \lambda hg = Mg + mg + \lambda Hg - \lambda sg =$

$= F_0 - \lambda g \cdot s \rightarrow$ lineáris

↓

ha $s > H$: $F = F_0 - \lambda Hg = F_1$

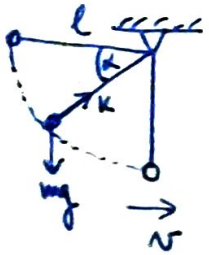


$W = \frac{F_0 + F_1}{2} \cdot H = 1280\,J$

Hasznos munka: $W_h = MgH = 800\,J$

hatásfok: $\eta = \frac{W_h}{W} = 0{,}625$ (62,5% ≈ 63%)

F5



Kötélerő munkája nulla, hiszen kötélirányban nincs elmozdulás.

$$W_{mg} = mgl = \Delta E_{kin} = \frac{1}{2}mv^2$$

$$v = \sqrt{2gl}$$

Energiamegmaradás: (helyzeti energia nullpontja az ingatest magassága, amikor a legalsó helyzetben van)

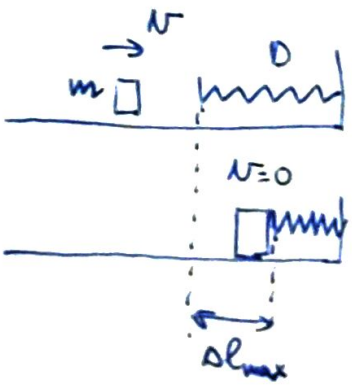
$$mgl = \frac{1}{2}mv^2 \quad \text{(ekvivalens az előző munkatétellel)}$$

F6

$m = 10\ kg$

$v = 10\ m/s$

$D = 2000\ N/m$



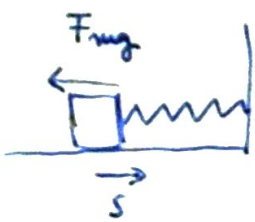
Energiamegmaradás:

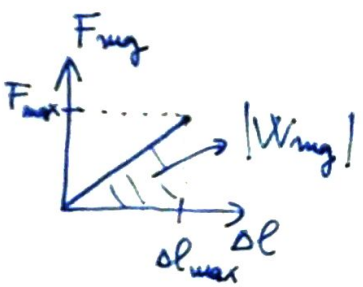
$$\frac{1}{2}mv^2 = \frac{1}{2}D\cdot\Delta l_{max}^2 \rightarrow \Delta l_{max} = \sqrt{\frac{mv^2}{D}} = 0{,}7\ m$$

Munkatétel:

$$W_{mg} = \Delta E_{kin}$$

$$-\frac{1}{2}D\Delta l_{max}^2 = -\frac{1}{2}mv^2$$





$$F_{max} = D\cdot\Delta l_{max}$$

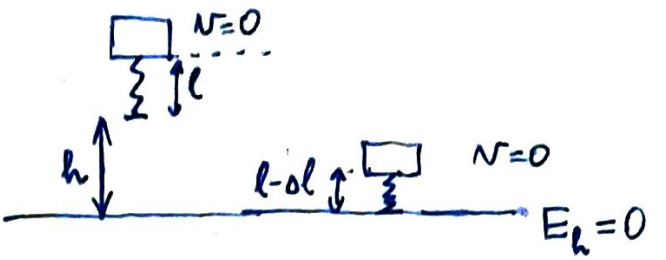
$$|W_{mg}| = \frac{1}{2}F_{max}\cdot\Delta l_{max} =$$

$$= \frac{1}{2}D\Delta l_{max}^2$$

F7. $m = 5\,kg$

$D = 1000\,N/m$

$h = 2m$



Energiamegmaradás:

$$mg(l+h) = \frac{1}{2} D \Delta l^2 + mg(l-\Delta l)$$

$$mg(h+\Delta l) = \frac{1}{2} D \Delta l^2$$

$$D\Delta l^2 - 2mg\Delta l - 2mgh = 0$$

$$1000\Delta l^2 - 100\Delta l - 200 = 0$$

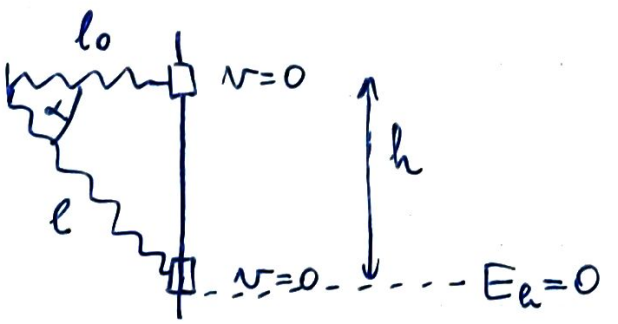
$$10\Delta l^2 - \Delta l - 2 = 0$$

$$\Delta l = \frac{1 \pm \sqrt{1^2 - 4 \cdot 10 \cdot (-2)}}{2 \cdot 10} = \frac{1 \pm 9}{20} \rightarrow \Delta l = \frac{1+9}{20} m = 0{,}5m$$

F8. $l_0 = 1m$

$m = 1kg$

$D = 50\,N/m$



Energiamegmaradás:

$$mgh = \frac{1}{2} D \cdot \Delta l^2$$

$$mg\sqrt{(l_0+\Delta l)^2 - l_0^2} = \frac{1}{2} D \Delta l^2$$

$$\left(\frac{2mg}{D}\right)^2 \cdot (\Delta l^2 + 2 l_0 \Delta l) = \Delta l^4$$

$$\Delta l^3 - 0{,}16\Delta l^2 - 0{,}32\Delta l = 0$$

$$\Delta l^2 - 0{,}16\Delta l - 0{,}32 = 0 \rightarrow \Delta l = 0{,}76m \text{ (számológép)}$$

$$\cos\alpha = \frac{l_0}{l_0 + \Delta l} = \frac{1}{1{,}76} \rightarrow \alpha = 55{,}4°$$