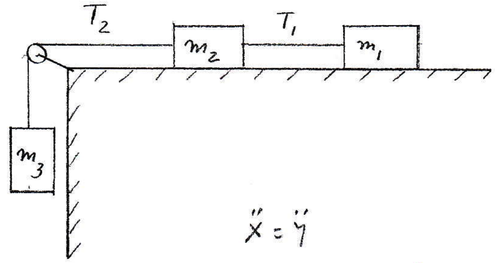
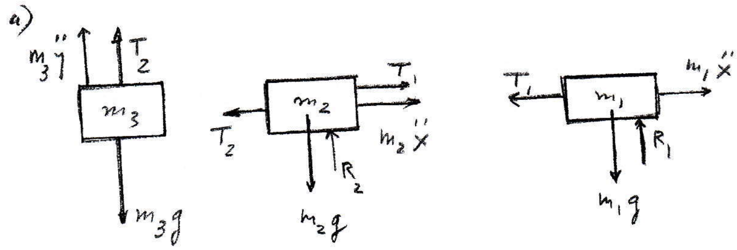
5.1 5.1



$\ddot{x} = \ddot{y}$

a)



b)

$$\left.\begin{aligned} T_2 &= m_3 g - m_3\ddot{y} \\ T_2 &= T_1 + m_2\ddot{x} \\ T_1 &= m_1\ddot{x} \end{aligned}\right\} \quad m_3 g - m_3\ddot{x} = m_1\ddot{x} + m_2\ddot{x}\,; \quad \ddot{x} = \frac{m_3}{m_1+m_2+m_3}\,g = \frac{2}{1+2+2}\,g = \frac{2}{5}\,g$$

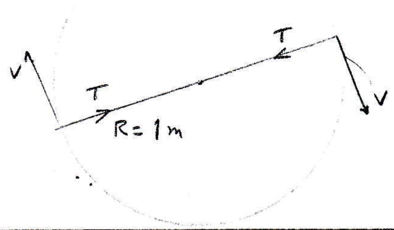
c)

$$T_1 = m_1\frac{2}{5}g = \frac{2}{5}\,1 = \frac{2}{5}\ \text{kg força}$$

$$T_2 = T_1 + m_2\ddot{x} = \frac{2}{5} + 2\cdot\frac{2}{5} = \frac{2}{5} + \frac{4}{5} = \frac{6}{5}\ \text{kg f}$$

5.3 5.3

$$a = \frac{V^2}{R} \qquad F = ma = \frac{mV^2}{R} = \frac{1\cdot 5^2}{1} = 25\,N$$

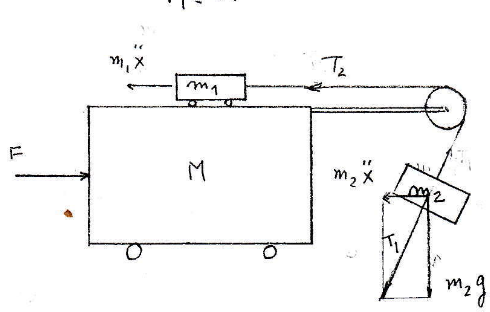


5.5 5.5

$m_1 = 5$

$m_2 = 4$

$M = 21$



$$T_1^2 = (m_2 g)^2 + (m_2\ddot{x})^2$$

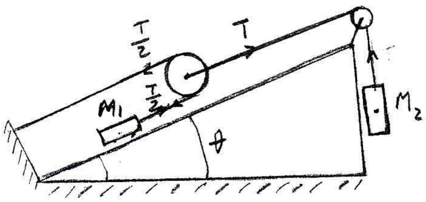
$$T_2 = m_1\ddot{x}$$

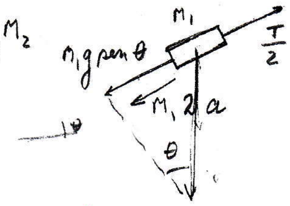
Mas $T_1^2 = T_2^2$ e vem $(m_2 g)^2 + (m_2\ddot{x})^2 = (m_1\ddot{x})^2$

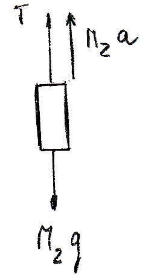
$$16 g^2 = 25\ddot{x}^2 - 16\ddot{x}^2\,; \quad 9\ddot{x}^2 = 16 g^2 \quad \ddot{x} = \frac{4}{3}g$$

$$F = (M+m_1+m_2)\,\ddot{x} = (21+5+4)\,\frac{4}{3}g = 40g = 392\,N$$

5.6 5.6







$\theta = 30°$

$M_1 = 0{,}4$ Kg

$M_2 = 0{,}2$ Kg

$$\frac{T}{2} = M_1 2a + M_1 g \, \text{sen}\,\theta \qquad T = M_2 g - M_2 a$$

$$T = M_1 4a + 2 M_1 g \, \text{sen}\,\theta = M_2 g - M_2 a$$

$$(4M_1 + M_2)a = (M_2 - 2M_1 \, \text{sen}\,\theta) g$$

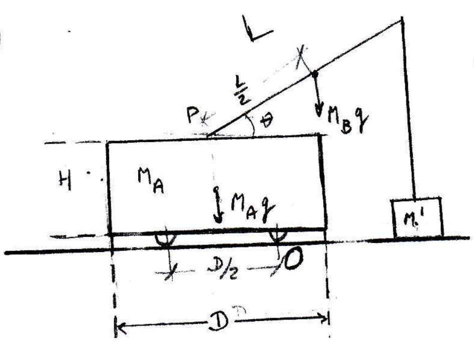
$$a = \frac{M_2 - 2M_1 \, \text{sen}\,\theta}{4M_1 + M_2} g = \frac{0{,}2 - 2 \cdot 0{,}4 \cdot 0{,}5}{4 \cdot 0{,}4 + 0{,}2} g = -\frac{0{,}2}{1{,}8} g = -\frac{g}{9}$$

$$T = M_2 g - M_2 a = 0{,}2\left(g + \frac{1}{9}g\right) = 0{,}2 \cdot \frac{10}{9} g = \frac{2}{9} g = 0{,}222 \text{ kgf} =$$

$= 222$ grama força.

5.7 5.7

a)



Σ Momentos em relação ao ponto O = 0

Momento da força $M_B g$ em relação ao ponto O =

$$= \left(\frac{L}{2}\cos\theta - \frac{D}{4}\right) M_B g$$

Momento da força $M'g$ em relação ao ponto O =

$$\left(L\cos\theta - \frac{D}{4}\right) M'g$$

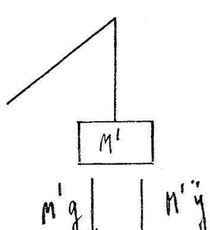
Momento da força $M_A g$ em relação ao ponto O:

$$M_A g \frac{D}{4}$$

$$M_A g \frac{D}{4} > \left(\frac{L}{2}\cos\theta - \frac{D}{4}\right) M_B g + \left(L\cos\theta - \frac{D}{4}\right) M'g$$

$$M' \leq \frac{M_A g \frac{D}{4} - \left(\frac{L}{2}\cos\theta - \frac{D}{4}\right) M_B g}{L\cos\theta - \frac{D}{4}} = M_{MAX} = \frac{(M_A + M_B)D - 2L\cos\theta \, M_B}{4L\cos\theta - D} g$$

b)

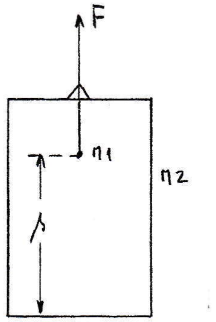


$$\left(L\cos\theta - \frac{D}{4}\right)(M'g + M'\ddot{y}) = M_A g \frac{D}{4} - \left(\frac{L}{2}\cos\theta - \frac{D}{4}\right) M_B g$$

$$F_{MAX} = M'g + M'\ddot{y} = M_{MAX} g \qquad M'\ddot{y} = (M_{MAX} - M')g \qquad \ddot{y} = \frac{M_{MAX} - \frac{4}{5}M_{MAX}}{\frac{4}{5}M_{MAX}} g = \frac{\frac{1}{5}}{\frac{4}{5}} g = \frac{1}{4} g$$

$$\ddot{y} = \frac{1}{4}g \quad \dot{y} = \frac{1}{4}gt \quad y = \frac{1}{8}gt^2 = L\sin\theta \; ; \quad t^2 = \frac{8L\sin\theta}{g} ; \quad t = \sqrt{\frac{8L\sin\theta}{g}}$$

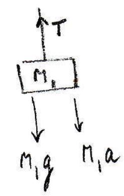
5.9 5.9



a) $F=(M_1+M_2)(g+a)$

$$a=\frac{F}{M_1+M_2}-g$$

b)



$$T=M_1(a+g)=\frac{M_1}{M_1+M_2}F$$

c) $F-M_2g=M_2a \qquad a=\frac{F}{M_2}-g=a_{M_2/F}$

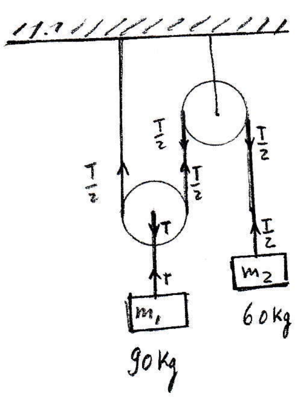
A aceleração de M_1 passa a ser $-g=a_{M_1/F}$

d) $a_{M_1/M_2}=a_{M_1/F}-a_{M_2/F}=-g-\frac{F}{M_2}+g=-\frac{F}{M_2}$

$$V_{M_1/M_2}=-\frac{F}{M_2}t$$

$$X_{M_1/M_2}=-\frac{1}{2}\frac{F}{M_2}t^2 \qquad -h=-\frac{1}{2}\frac{F}{M_2}T^2 \qquad T=\sqrt{\frac{2M_2h}{F}}$$

5.11 5.11



$$\begin{cases} T=m_1g-m_1\ddot{y}_1 \\ \frac{T}{2}=m_2g+m_2\ddot{y}_2 \\ \ddot{y}_2=2\ddot{y}_1 \end{cases}$$

$$m_1g-m_1\ddot{y}_1=2m_2g+2m_2\ddot{y}_2$$

$$m_1g-2m_2g=m_1\ddot{y}_1+2m_2\,2\ddot{y}_1$$

$$\ddot{y}_1=\frac{m_1g-2m_2g}{m_1+4m_2}=\frac{m_1-2m_2}{m_1+4m_2}g$$

$$T=m_1g-m_1\frac{m_1-2m_2}{m_1+4m_2}g=m_1\left(1-\frac{m_1-2m_2}{m_1+4m_2}\right)g=m_1g\frac{6m_2}{m_1+4m_2}$$

A força total na trave é $F=T+\frac{T}{2}=\frac{3}{2}T=\frac{3}{2}\frac{6m_1m_2}{m_1+4m_2}g=9\frac{m_1m_2}{m_1+4m_2}g=9\frac{90\cdot60}{90+4\cdot60}g=147{,}3\,g$

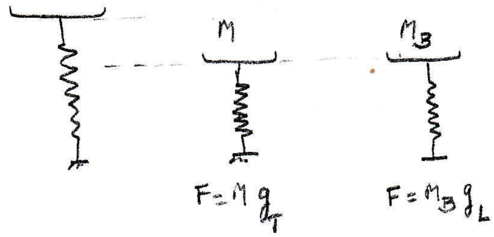
Em conclusão: Peso ~~total~~ sem roldanas: 90+60=150 kgf

Peso aparente com as roldanas: 147,3 kgf

Poupança no peso: 150 − 147,3 = 2,7 kgf

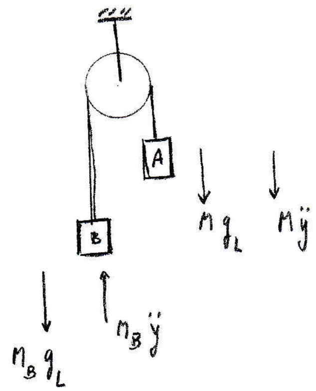
5.13 5.13

A leitura da balança de mola é proporcional à compressão da mola que, por sua vez, é proporcional à força exercida no prato.



$M g_T = M_B g_L = 9,8\ N$

$M = 1\ kg$



A equação de equilíbrio dinâmico vem:

$M_B g_L - M_B \ddot{y} = M g_L + M \ddot{y}$; $(M_B - M) g_L = (M_B + M)\ddot{y}$

$$\ddot{y} = \frac{M_B - M}{M_B + M} g_L = 1,2\ m/s^{-2}$$

$\frac{M_B - M}{M_B + M} \cdot \frac{9,8}{M_B} = 1,2$; $M_B - M = \frac{1,2}{9,8} M_B (M_B + M)$

$M_B - M = \frac{1,2}{9,8} M_B^2 + \frac{1,2}{9,8} M_B M$; $\frac{1,2}{9,8} M_B^2 + \left(\frac{1,2}{9,8} - 1\right) M_B + 1 = 0$; $M_B^2 + \left(1 - \frac{9,8}{1,2}\right) M_B + \frac{9,8}{1,2} = 0$

$M_B^2 - 7,167 M_B + 8,167 = 0$ $M_B = \frac{1}{2}\left(7,167 \pm \sqrt{7,167^2 - 4 \cdot 8,167}\right) = \frac{1}{2}(7,167 \pm 4,324)$

$\therefore$

$M_B = 5,746$ e de $M_B g_L = 9,8$ vem $g_L = \frac{9,8}{5,746} = 1,7\ m/s^{-2} \simeq \frac{1}{6} g_T$

$M_B = 1,4215$ e de $M_B g_L = 9,8$ vem $g_L = \frac{9,8}{1,4215} = 6,89\ m/s^{-2}$

Portanto $M_B = 5,746\ kg$ é o valor que dá um g_L mais próximo de $\frac{1}{6} g_T$.