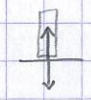
(i) Cap. 1.2.

1) a) $R = m \times g = 90 \times 9{,}8 = 882\,N$



b) $R = 90 \times 9{,}8 = 882\,N$

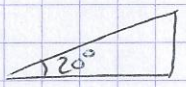
c) $a = 3\,m/s^2$

$R = 882 + 90 \times 3 = 1152\,N$

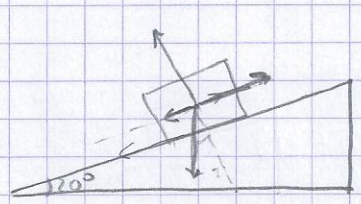
d) $R = 882 - 90 \times 3 = 612\,N$

e) $R = 0\,N$

2) $m = 1000\,kg$



a)



$$\begin{cases} R - mg\cos 20° = 0 \\ F - mg\,\text{sen}\,20° = 0 \end{cases} \Leftrightarrow \begin{cases} \\ F = 1000 \times 9{,}8 \times \text{sen}\,20° = 3352\,N \end{cases}$$

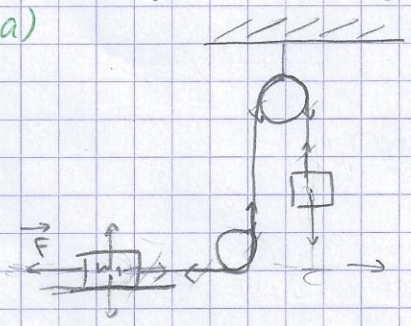
b) $F = ma + mg\,\text{sen}\,20° = 1000 \times 0{,}2 + 3352 = 3552\,N$

c) $R = mg\cos 20° = 1000 \times 9{,}8 \times \cos 20° = 9209\,N$

$F_a = 3352\,N \quad ; \quad F_b = 3552\,N$

3) $m_1 = 50\,g \quad m_2 = 80\,g \quad F = 1\,N$ $\qquad F = 120 \times 10^{-3}\,a$

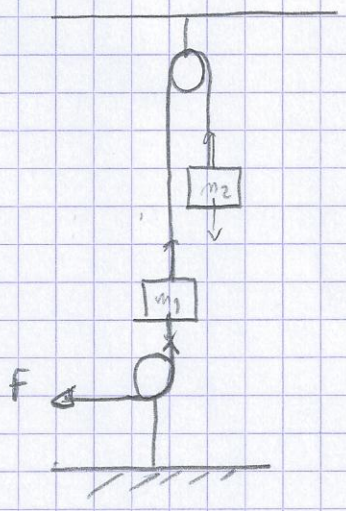
a)



$$\begin{cases} T = m_2(g+a) \\ F = m_1 a + T \end{cases} \Leftrightarrow \begin{cases} T = 80 \times 10^{-3}(9{,}8+a) \\ 1 = 50 \times 10^{-3} a + 784 \times 10^{-3} + 80 \times 10^{-3} a \end{cases}$$

$$\begin{cases} \\ 1 = 130 \times 10^{-3} a + 784 \times 10^{-3} \end{cases} \Leftrightarrow \begin{cases} T = 0{,}92\,N \\ a = 1{,}66\,m/s^2 \end{cases}$$

b)

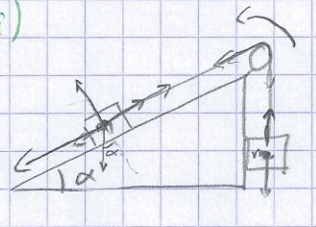


$$\begin{cases} T = m_2(g+a) \\ F + m_1 g = T + m_1 a \end{cases}$$

$$\begin{cases} T = 0{,}08(9{,}8+a) \\ 1 + 0{,}05 \times 9{,}8 = 0{,}784 + 0{,}08a + 0{,}05a \end{cases} \Leftrightarrow$$

$$\Leftrightarrow \begin{cases} \\ 1{,}49 = 0{,}784 + 0{,}13a \end{cases} \Leftrightarrow \begin{cases} \\ a = \frac{0{,}706}{0{,}13} \end{cases} \Rightarrow \begin{cases} T = 1{,}22\,N \\ a = 5{,}43\,m/s^2 \end{cases}$$

4) a)



$$\begin{cases} m_1 g \operatorname{sen}\alpha = T + m_1 a \\ T = m_2(g+a) \end{cases}$$

$$\Leftrightarrow \begin{cases} T = m_1 g \operatorname{sen}\alpha - m_1 a \\ m_1 g \operatorname{sen}\alpha - m_1 a = m_2 g + m_2 a \end{cases} \Leftrightarrow$$

$$\Leftrightarrow \begin{cases} \\ m_1 a + m_2 a = m_1 g \operatorname{sen}\alpha - m_2 g \end{cases} \Leftrightarrow$$

$$\Leftrightarrow \begin{cases} \\ a(m_1 + m_2) = (m_1 \operatorname{sen}\alpha - m_2) g \end{cases} \Leftrightarrow$$

$$\Leftrightarrow \begin{cases} T = m_1 g \operatorname{sen}\alpha - m_1 \times \frac{m_1 \operatorname{sen}\alpha - m_2}{m_1 + m_2} g \\ a = \frac{m_1 \operatorname{sen}\alpha - m_2}{m_1 + m_2} g \end{cases}$$

(2)

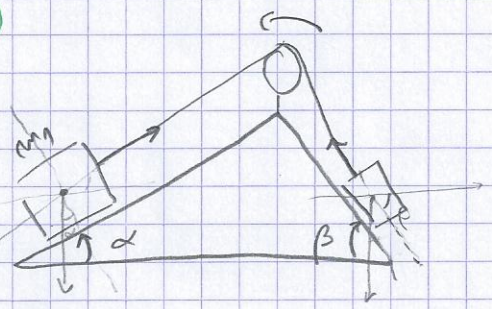
$$T = m_1 g \left[\operatorname{sen}\alpha - \frac{m_1 \operatorname{sen}\alpha - m_2}{m_1 + m_2} \right]$$

$$T = m_1 g \left[\frac{m_1 \operatorname{sen}\alpha + m_2 \operatorname{sen}\alpha - m_1 \operatorname{sen}\alpha + m_2}{m_1 + m_2} \right]$$

$$T = m_1 g \times \frac{m_2 \operatorname{sen}\alpha + m_2}{m_1 + m_2}$$

$$T = m_1 m_2 g \times \frac{\operatorname{sen}\alpha + 1}{m_1 + m_2} \;//$$

b)



$$\begin{cases} m_1 a + T = m_1 g \operatorname{sen}\alpha \\ m_2 (g \operatorname{sen}\beta + a) = T \end{cases}$$

$$\begin{cases} T = m_1 (g \operatorname{sen}\alpha - a) \\ m_2 (g \operatorname{sen}\beta + a) = m_1 (g \operatorname{sen}\alpha - a) \end{cases}$$

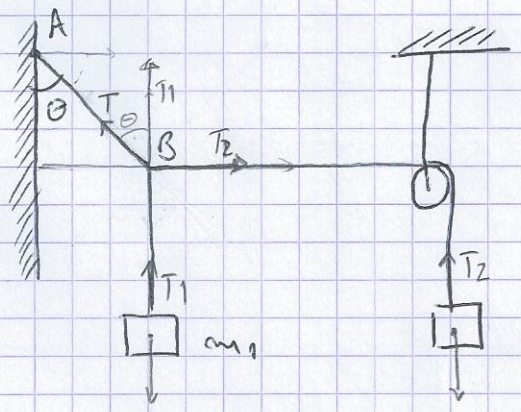
$$\begin{cases} (m_2 + m_1) a = (m_1 \operatorname{sen}\alpha - m_2 \operatorname{sen}\beta) g \\ \hline \end{cases} \Leftrightarrow$$

$$\Leftrightarrow \begin{cases} a = \dfrac{m_1 \operatorname{sen}\alpha - m_2 \operatorname{sen}\beta}{m_1 + m_2} g \\ T = m_1 g \operatorname{sen}\alpha - m_1 \times \dfrac{m_1 \operatorname{sen}\alpha - m_2 \operatorname{sen}\beta}{m_1 + m_2} g \end{cases}$$

$$\Leftrightarrow \begin{cases} \longrightarrow \\ T = m_1 g \dfrac{m_1 \operatorname{sen}\alpha + m_2 \operatorname{sen}\alpha - m_1 \operatorname{sen}\alpha + m_2 \operatorname{sen}\beta}{m_1 + m_2} \end{cases}$$

$$\Leftrightarrow \begin{cases} \\ T = m_1 m_2 \dfrac{\operatorname{sen}\alpha + \operatorname{sen}\beta}{m_1 + m_2} g \end{cases}$$

5



$$\begin{cases} T_2 = m_2 g \\ T_1 = m_1 g \\ T\cos\theta = T_1 \\ T\operatorname{sen}\theta = T_2 \end{cases} \Leftrightarrow \begin{cases} T_2 = 39,2 \\ T_1 = 29,4 \\ T\cos\theta = 29,4 \\ T\operatorname{sen}\theta = 39,2 \end{cases}$$

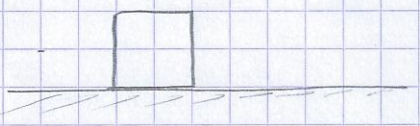
$$\therefore \quad tg\,\theta = \frac{39,2}{29,4} \Leftrightarrow \theta \simeq 53,1^\circ$$

logo, $T\cos(53,1) = 29,4 \Leftrightarrow$

$\Leftrightarrow \quad T = 49\,N$

6) $m = 10\,kg$

$\vec{F} = (4t^2 - t)\,\vec{i}$



a) $I(t) = \int (4t^2 - t)\,dt = \frac{4t^3}{3} - \frac{t^2}{2}$ kg m/s

b) $I(4) = 77,3$ kg m/s

c) $I = \Delta p = 77,3$ kg m/s

d) $p = mv \Leftrightarrow v = \frac{p}{m} = \frac{77,3}{10}\ \frac{kg\,m/s}{kg} = 7,73$ m/s

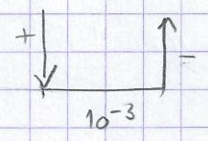
e) $v = \frac{p}{m} = \frac{4t^3}{30} - \frac{t^2}{20} = \frac{2t^3}{15} - \frac{t^2}{20}$ m/s

f) $x(t) = \frac{2t^4}{15\times 4} - \frac{t^3}{20\times 3} = \frac{t^4}{30} - \frac{t^3}{60}$ m

(3)

7) $|v| = 10\ m/s$

$|v| = 8\ m/s$
$F = 180\ N$
$t = 10^{-3}\ s$

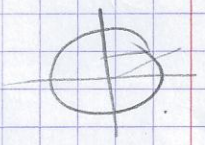


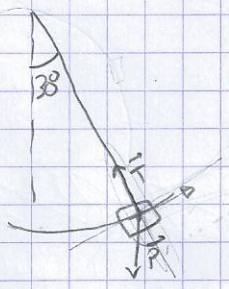
$$a = \left| \frac{+8 + 10}{10^{-3}} \right| = 18 \times 10^{+3}\ m/s^2$$

$$F = m \times a \iff 180 = m \times 18 \times 10^{+3}$$

$$\iff m = \frac{180}{18 \times 10^{+3}} \iff m = 10 \times 10^{-3}\ kg \Rightarrow m = 10\ g$$

8)





$v(30^s) = 2\ m/s$

a) $a_n = \frac{v^2}{R} = \frac{4}{1} = 4\ m/s^2$

$$\begin{cases} T = m a_n + P \cos 30^\circ \\ P \sin 30^\circ = m a_t \end{cases} \iff$$

$$\Rightarrow a_t = \frac{P \sin 30^\circ}{m} = \frac{1 \times 9{,}8 \times 1/2}{1} = 4{,}9\ m/s^2$$

b)

$\vec{a} = \vec{a_t} + \vec{a_n}$

$\vec{a} = 4{,}9\,\vec{u}_t + 4\,\vec{u}_n$

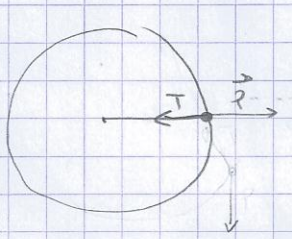
$|\vec{a}| = \sqrt{4{,}9^2 + 4^2} = 6{,}33\ m/s^2$

$tg\,\theta = \frac{4}{4{,}9} \iff \theta = 39{,}23^\circ$

9) $m = 0{,}4\ kg$

$l = 0{,}8\ m$

$f = 80\ v/min$



$80\ v/min \rightarrow 1{,}33\ v/s$

$P = 2\pi \times r = 5{,}03\ m$

$\frac{80 \times 5{,}03}{60} = 6{,}7\ m/s$

a) $T = m a_c$

$T = m \times \frac{v^2}{l} = 0{,}4 \times \frac{6{,}7^2}{0{,}8} = 22{,}4\ N$

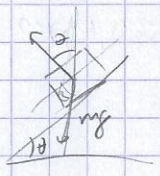
b) $1\ kgf \rightarrow 9{,}8\ N$
$50\ kgf \rightarrow 490\ N$

$490 = 0{,}4 \times \frac{v^2}{0{,}8} \iff v = \sqrt{980} \simeq 31{,}3\ m/s$

$w = \frac{v}{r} = \frac{31{,}3}{0{,}8} = 39{,}13\ rad/s$

10) $v = 63\ km/h$ $\quad r = 300\ m$ $\quad v = \frac{63 \times 10^3}{3600} = 17,5\ m/s$

a) $F = m \cdot \frac{17,5^2}{300}$

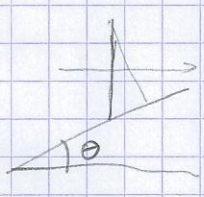


$$\begin{cases} N\cos\theta = mg \\ N\operatorname{sen}\theta = F \end{cases} \Rightarrow$$

$$\rightarrow \operatorname{tg}\theta = \frac{F}{mg} = \frac{\frac{m\,17,5^2}{300}}{m \times 9,8} = 0,104$$

$$\Leftrightarrow \theta = 5,94°$$

b)



$\theta = 5,94°$

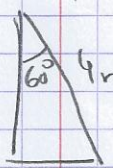
11) ~~Enunciado dados~~ supor que $l = 4\ m$ e $\alpha = 30°$

a) $m = 6\ kg$ $\quad w = 10\ rev/min$

$V = wr$

$= \frac{10}{60} \times 2\pi \times 4\operatorname{sen}60°$

$= 3,63\ m/s$

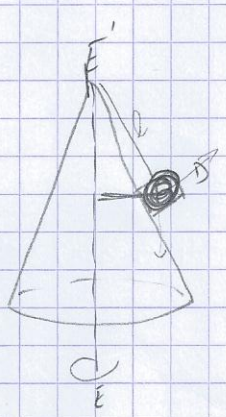


$\operatorname{sen}60° = \frac{r}{4}$

$r = 4\operatorname{sen}60°$

$r = 4 \times \frac{\sqrt{3}}{2}$

$r = 2\sqrt{3}$



b)

$$\begin{cases} T\cos60° + R\operatorname{sen}60° = mg \\ T\operatorname{sen}60° - R\cos60° = m\frac{v^2}{r} \end{cases}$$

$$\Leftrightarrow \begin{cases} \frac{1}{2}T + \frac{\sqrt{3}}{2}R = 6 \times 9,8 \\ \frac{\sqrt{3}}{2}T - \frac{1}{2}R = \frac{6 \times 3,63^2}{2\sqrt{3}} \end{cases} \Leftrightarrow \begin{cases} T + \sqrt{3}R = 117,6 \\ \sqrt{3}T - R = 45,6 \end{cases}$$

$$\Leftrightarrow \begin{cases} T = 117,6 - \sqrt{3}R \\ \sqrt{3} \times 117,6 - 3R - R = 45,6 \end{cases} \Leftrightarrow R \approx 39,5\ N$$

d) $R = 0$

$$\begin{cases} T = 117,6 \\ \frac{\sqrt{3}}{2}T = \frac{6 \times v^2}{2\sqrt{3}} \end{cases}$$

c) $T = 117,6 - \sqrt{3}R = 49,2\ N$

$$\begin{cases} \text{—} \\ T = 2\sqrt{2} \end{cases} \Leftrightarrow \begin{cases} v = 7,67\ m/s \end{cases}$$

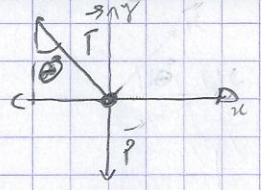
$V = wr \Leftrightarrow w = \frac{v}{r} \Leftrightarrow w = 2,21\ rad/s$

(4)

12) $m = 1,2\ kg$

$L = 1,16\ m$

$\omega = 30\ rad/s$ $\quad V = \omega R$



Pêndulo

$$\begin{cases} T\cos\theta = mg \\ T\sin\theta = \dfrac{mv^2}{R} \end{cases} \Leftrightarrow$$

$V = 30 \times 1,16 \sin\theta$

$= 34,8 \sin\theta$ $\quad \Rightarrow \quad tg\theta = \dfrac{\frac{mv^2}{R}}{mg} = \dfrac{mv^2}{mgR}$

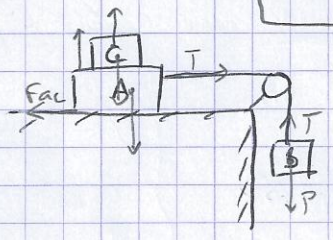
$$\Rightarrow Tg\theta = \frac{v^2}{gR} \Leftrightarrow tg\theta = \frac{(\omega R)^2}{gR} \Leftrightarrow tg\theta = \frac{\omega^2 R^2}{gR} \Leftrightarrow$$

$$\Leftrightarrow tg\theta = \frac{\omega^2 R}{g} \Leftrightarrow \frac{\sin\theta}{\cos\theta} = \frac{30^2 \times 1,16 \sin\theta}{9,8} \Leftrightarrow \cos\theta = 0,009 \Rightarrow$$

$\Rightarrow \theta = 89,5°$ ✓

e $T\cos(89,5) = 1,2 \times 9,8 \Leftrightarrow T = 1307\ N$

13)



$m_A = 10\ kg$ $\quad m_B = 5\ kg$

$\mu_e = \mu_c = 0,20$

a) $T = m_B g \Leftrightarrow T = 5 \times 9,8 \Leftrightarrow T = 49\ N$

$T = F_{ac} \Leftrightarrow T = \mu_c . N$

$F_{ac} = N$

$\Leftrightarrow 49 \overset{*}{=} 0,20\,(10 + m_C)\,9,8$

$\Leftrightarrow 10 + m_C = 25 \Leftrightarrow m_C = 15\ kg$

* $N = (m_A + m_C) g$

b) $T - F_{ac} = ma \Leftrightarrow m_B g - \mu_c (m_A g) = (m_A + m_B) . a$

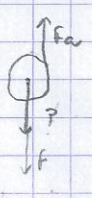
$\Leftrightarrow 5 \times 9,8 - 0,20 \times 10 \times 9,8 = 15 . a$

$\Leftrightarrow a = 1,96\ m/s^2$

14) $F_a = ?$

$m = 0,4\ kg$

$a = 9,0\ m/s^2$



$P - F_a = F$

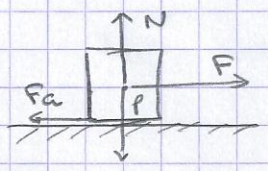
$\Leftrightarrow 0,4 \times 9,8 - F_a = 0,4 \times 9$

$\Leftrightarrow F_a = 0,32\ N$

15) $m = 4\,kg$

$F < 0{,}8\,kgf$

$\mu_e = ?$



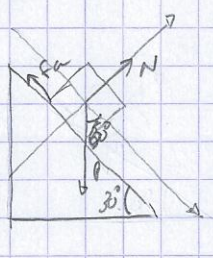
$F - Fa = 0 \Leftrightarrow F - \mu_c N = 0$

$\Leftrightarrow 0{,}8 - \mu_c \cdot mg = 0$

$\Leftrightarrow 0{,}8 - \mu_c \cdot 4 \times 9{,}8 = 0$

$\Leftrightarrow \mu_c = 0{,}02$

16)



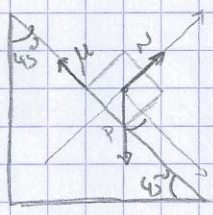
$F = 0$

$$\begin{cases} P\cos 60° = Fa \\ N = P\,\text{sen}\,60° \end{cases} \Leftrightarrow \begin{cases} mg\cos 60° = \mu_e N \\ \text{---} \end{cases}$$

$mg\cos 60° = \mu_e \cdot mg \cdot \text{sen}\,60° \Leftrightarrow$

$\Leftrightarrow \mu_c = \cot g\, 60° \Leftrightarrow \mu_c = 0{,}58$

17)



$P\cos 45° - Fa = F$

$P\cos 45° - \mu \cdot P\,\text{sen}\,45° = m \times a$

$g\frac{\sqrt{2}}{2} - \mu \cdot g\frac{\sqrt{2}}{2} = a \Rightarrow g\frac{\sqrt{2}}{2} - \mu' g\frac{\sqrt{2}}{2} = a'$

Bem: $V = \frac{\Delta x}{\Delta t}$

$a' t^2 = 2at$

$V_2 = \frac{\Delta x}{\frac{\Delta t}{2}} \Rightarrow V_2 = 2V$ logo $a'\left(\frac{t}{2}\right) = 2at \Leftrightarrow a' = 4a$

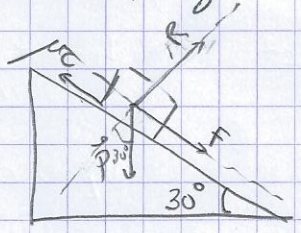
$g\frac{\sqrt{2}}{2} - \mu' g\frac{\sqrt{2}}{2} = 4g\frac{\sqrt{2}}{2} - 4\mu \cdot g\frac{\sqrt{2}}{2}$

$1 - \mu' = 4 - 4\mu$

$-\mu' = 3 - 4\mu$

$\mu' = 4\mu - 3$

(5) (18) $m = 0,8\ kg$ $\theta = 30°$ $\mu_c = 0,3$



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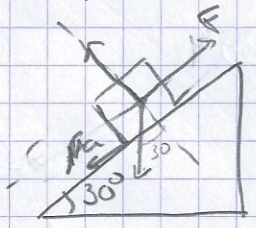


a) $a = 0$

$$\begin{cases} F = P\,sen\,30° + F_{ac} \\ R = P\cos 30° \end{cases} \quad \text{e } F_{ac} = \mu_c R$$

$F = 0,3 \times 0,8 \times 9,8 \cos 30° + 0,8 \times 9,8\, sen\, 30°$

$= 5,96\ N$

b) $a = 0$

$$\begin{cases} F = P\,sen\,30° - F_a \\ R = P\cos 30° \end{cases}$$

$F = 0,8 \times 9,8 \times sen\,30° - 0,3 \times 0,8 \times 9,8 \times \cos 30°$

$= 1,88\ N$

c) $a = 0,10\ m/s^2$

$F - P\,sen\,30° - F_a = ma \iff$

$\iff F = 0,8 \times 0,10 + 0,8 \times 9,8 \times sen\,30° + 0,3 \times 0,8 \times 9,8 \cos 30°$

$\iff F = 6,04\ N$

d) $a = 0,10\ m/s^2$

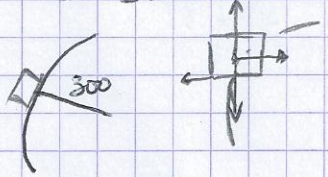
$+ P\,sen\,30° - F_a = ma + F \iff$

$\iff -F = 0,8 \times 0,10 - 0,8 \times 9,8 \times sen\,30° + 0,3 \times 0,8 \times 9,8 \times \cos 30°$

$\iff F = 1,80\ N$

$a = \frac{v^2}{r} \iff v = \sqrt{ar}$

19) $r = 300\ m$ $F = F_a$



$\iff F = \mu_c N$

$\iff ma = \mu_c mg \iff a = \mu_c g$

bomacha $\mu_c = 0,75$ $\iff \frac{v^2}{r} = \mu_c g \iff v = \sqrt{r \mu_c g} \Rightarrow v = \sqrt{2940 \mu_c}$

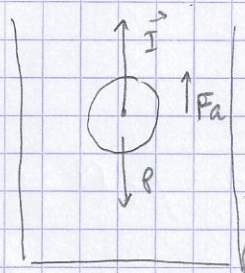
molhado $\mu_c = 0,5$

seco $\mu_c = 0,25$

$\Rightarrow \begin{cases} B \to v = 46,96\ m/s \\ M \to v = 38,34\ m/s \\ S \to v = 27,11\ m/s \end{cases}$

20) $r = 2\,cm$ — $\rho_g = 1{,}26\ g/cm^3$ — $\mu = 833 \times 10^{-3}\ Pa \cdot s$

$\rho_e = 1{,}50\ g/cm^3$ — $\vec{a}_e = 1{,}00\ m/s^2$ — $b = 6\pi\mu R$



$P - I - fa = ma$ — $v_l \Rightarrow a = 0\ m/s^2$

$$\rho_e V_e g - \rho_g V_e g + b v = 0 \quad (1)$$

$\rho = \frac{m}{V}$

$m = \rho V$

$\vec{F}_a = -bv$

$b = 6\pi\mu r$

$$P = \rho_e V_e g = \frac{1{,}50 \times 10^{-3}}{10^{-6}} \times \frac{4}{3}\pi \times 0{,}02^3 \times 9{,}8$$

$$= 0{,}49\ N$$

$$I = \rho_g V_e g = 1260 \times \frac{4}{3}\pi \times 0{,}02^3 \times 9{,}8$$

$$= 0{,}41\ N$$

$$Fa = bv = 6\pi\mu r v$$

$$= 6\pi \times 833 \times 10^{-3} \times 0{,}02 \times v$$

$$= 0{,}31 v$$

Subst. (1)

$$0{,}49 - 0{,}41 - 0{,}31 v = 0 \Leftrightarrow$$

$$v = 0{,}26\ m/s$$ //

se $a = 1{,}00\ m/s^2$

$$P - I - fa = m \times 1$$

$$0{,}49 - 0{,}41 - 0{,}31 v = \rho_e V$$

$$-0{,}31 v = 1500 \times \frac{4}{3}\pi \times 0{,}02^3 - 0{,}08$$

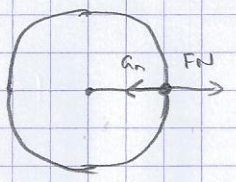
$$v = 0{,}10\ m/s$$ //

(6) (2) $m_e = 200g$ m. u. circular

$F_f = 1N \Rightarrow \Delta x = 1\,cm$

$l = 50cm$

a)



Lei de Hooke $F = -K(x - x_0)$

$1 = -K \times 0,01 \Leftrightarrow K = -100\ N/m$

$\omega = \frac{1}{2} \times 2\pi = \pi\ rad/s$

$v = \omega R = \pi \times 0,5 = 1,57\ m/s$

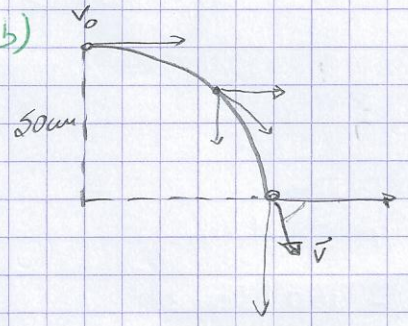
$a_N = \frac{v^2}{R} = \frac{1,57^2}{0,5} = 4,93\ m/s^2$

$F_N = m a_N = 200 \times 10^{-3} \times 4,93 = 0,986\,N$

Pela lei de Hooke: $0,986 = -(-100) \times (x - 0,50)$

$x = 0,51\ m \quad (51\ cm)$

b)



- $y = y_0 + v_{0y} t - \frac{1}{2} g t^2$

$0 = 0,5 + 0 - 4,9 t^2$

$t = 0,32\ s$

- $v_y = v_{0y} + g t \Leftrightarrow v_y = 9,8 \times 0,32$

$= 3,14\ m/s$

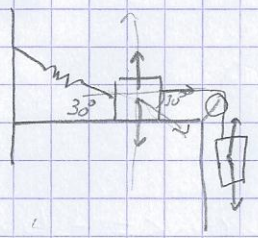
$\vec{v} = 1,57\,\hat{i} + 3,14\,\hat{j}$

Nota $|\vec{v}| = \sqrt{1,57^2 + 3,14^2} = 3,51\ m/s$

$tg\,\theta = \frac{1,57}{3,14} \Rightarrow \theta \simeq 63°$

(22) $K = 400\ N/m$

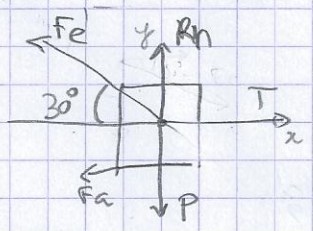
a)



$F = K(x - x_0)$

$F = 400\,l$

Fe



$$\begin{cases} T = m_2 g \\ Fe\cos 30° = T \\ Fe\ \text{sen}30° + Rn = P \end{cases}$$

$T = 4 \times 9{,}8 = 39{,}2\ N \Rightarrow 400\,l\cos 30° = 39{,}2 \Leftrightarrow l = 0{,}113\ m$

$11{,}3\ cm$

b) $Fa = \mu N = 0{,}4 \times Rn$

$$\begin{cases} T = m_2 g \\ Fe\cos 30° = T - Fa \\ Fe\ \text{sen}30° + Rn = P \end{cases} \qquad \begin{cases} T = 39{,}2\ N \\ 400\,l\cos 30° = 39{,}2 - 0{,}4\,Rn \\ Rn = 5 \times 9{,}8 - 400\,l\ \text{sen}30 \end{cases}$$

logo $400\,l\cos 30° = 39{,}2 - 0{,}4(49 - 200\,l)$

$346{,}4\,l = 39{,}2 - 19{,}6 + 80\,l$

$266{,}4\,l = 19{,}6$

$l = 0{,}074\ m \Rightarrow 7{,}4\ cm$