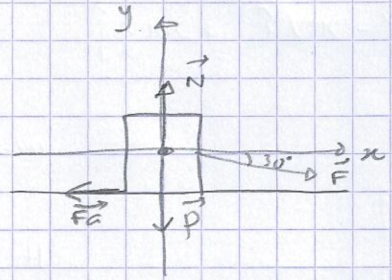
(1) cap. 1.3

1) $m = 2{,}0\ kg$ $\quad F = 10{,}0\ N$

$\Delta x = 10\ m$ $\quad \measuredangle \to 30°$

$\mu_e = 0{,}2$

$\mu_c = 0{,}1$



a)

b) $W = F \cdot \Delta x \cdot \cos\theta$

$W = 10 \cdot 10 \cdot \cos 30° = 86{,}0\ J$

c) $W = P \cdot \Delta x \cdot \cos 90°$

$= 0\ J$

d) $W = N \cdot \Delta x \cdot \cos 90°$

$= 0\ J$

e) $W = F_a\ \Delta x \cos 180°$

$= \mu_c \cdot N \cdot 10 \times (-1)$

$= -N$

$= -24{,}6\ J$

$N = P + F \operatorname{sen} 30°$

$= 2 \times 9{,}8 + 10 \operatorname{sen} 30°$

$= 19{,}6 + 5$

$= 24{,}6$

f) $\Delta E_c = W_{RES} = 86 + 0 + 0 - 24{,}6 = 62\ J$

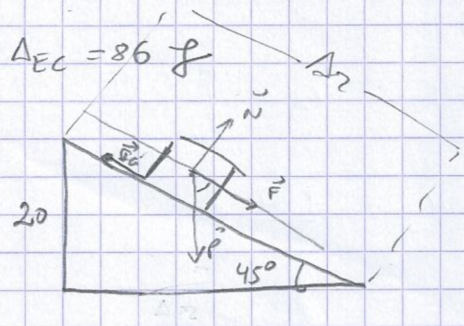
g) Só mudaria a e) e $\Delta E_c = 86\ J$

2) $m = 10\ kg$ $\quad \theta = 45°$

$h = 20\ m$

$\mu_e = 0{,}2$

$\mu_c = 0{,}1$



$\operatorname{sen} 45° = \frac{20}{\Delta x}$

$\Delta x = 28{,}28\ m$

a) $W = F_p \cdot \Delta x \cdot \cos(45°)$

$= 10 \times 9{,}8 \cdot 28{,}28 \cdot \cos(45°)$

$= 1960\ J$

b) $W = F_N \cdot \Delta x \cdot \cos(90°) = 0\ J$

c) $W = F_a \cdot \Delta x \cdot \cos(180°) =$

$= \mu_c N \cdot 28{,}28 \cos(180°)$

$= \mu_c\ mg \operatorname{sen} 45° \cdot 28{,}28 \cdot \cos(180°) = -196\ J$

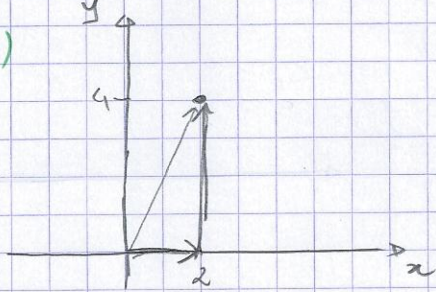
d) $\Delta E_c = W_{RES} = 1960 - 196 = 1764\ J$

e) $\Delta E_c = -960 - 196 = -2156\ J$

f) $\Delta E_c = 1960\ J$

③ $\vec{F} = (2y^2 - x^2)\,\hat{i} + 2xy\,\hat{j}$ $\qquad (0,0) \rightarrow (2,4)$

a)



$$W = \int_0^2 F_x(x,y)\,dx + \int_0^4 F_y(x,y)\,dy$$

Horizontal : $y = 0$

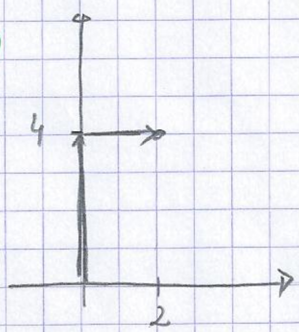
$$W_x = \int_0^2 -x^2\,dx = \left[-\frac{x^3}{3}\right]_0^2 = -\frac{8}{3}\ J$$

Vertical : $x = 2$

$$W_y = \int_0^4 4y\,dy = \left[2y^2\right]_0^4 = 32\ J$$

$$W = W_x + W_y = -\frac{8}{3} + 32 = \frac{88}{3}\ J$$

b)



$$W = \int_0^4 F_y(x,y)\,dy + \int_0^2 F_x(x,y)\,dx$$

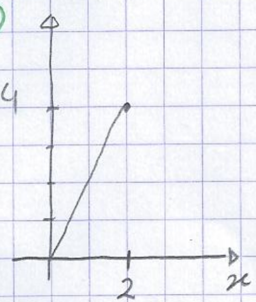
Vertical : $x = 0$

$$W_y = \int_0^4 0\,dy = 0\ J$$

Horizontal : $y = 4$ $\qquad W_x = \int_0^2 (32 - x^2)\,dx = \left[32x - \frac{x^3}{3}\right]_0^2 = 64 - \frac{8}{3} = \frac{184}{3}\ J$

$$W = W_x + W_y = \frac{184}{3}\ J$$

c)



$y = +\frac{4}{2}x + 0$

$y = 2x$

$$W = \int_0^2 F_x(x,y)\,dx + \int_0^4 F_y(x,y)\,dy$$

$\boxed{W_x}$ $y = 2x$

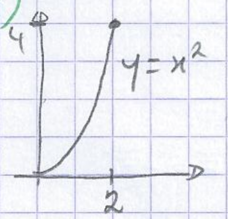
$$W_x = \int_0^2 (8x^2 - x^2)\,dx = \int_0^2 7x^2\,dx = \left[\frac{7x^3}{3}\right]_0^2 = \frac{56}{3}\ J$$

$\boxed{W_y}$ $x = \frac{y}{2}$

$$W_y = \int_0^4 2 \times \frac{y}{2} \times y\,dy = \int_0^4 y^2\,dy = \left[\frac{y^3}{3}\right]_0^4 = \frac{64}{3}\ J$$

$$W = \frac{56}{3} + \frac{64}{3} = \frac{120}{3} = 40\ J$$

② d)



$y = x^2 \Rightarrow x = \sqrt{y}$ $\qquad W = \int_0^2 F_x(x,y)\,dx + \int_0^4 F_y(x,y)\,dx$

$\boxed{W_x}$ $y = x^2$

$$W_x = \int_0^2 (2x^4 - x^2)\,dx = \left[\frac{2x^5}{5} - \frac{x^3}{3}\right]_0^2 = \frac{152}{15}\,J$$

$\boxed{W_y}$ $x = \sqrt{y}$ $\qquad \frac{1}{2}+1=$ $\qquad \frac{3}{2}+1=$

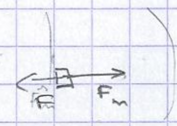
$$W_y = \int_0^4 F_y(x,y)\,dy = \int_0^4 2 \cdot y^{3/2}\,dy = 2\left[\frac{y^{5/2}}{5/2}\right]_0^4 = 2 \times \frac{2}{5} \times \left(\sqrt{4}\right)^5$$

$$= \frac{4}{5} \times 2^5 = \frac{128}{5}\,J$$

$$W = \frac{152}{15} + \frac{128}{5} = \frac{536}{15}\,J$$

e) Não é conservativa

4) $\Delta x = 0{,}50\,m$ $\qquad F = 0 \to 250\,N$



a) $F = K(x - x_0)$

$250 = K \times 0{,}50 \Leftrightarrow K = 500\,N/m$

b) $W_{mola} = \frac{1}{2}Kx_i^2 - \frac{1}{2}Kx_f^2 = -\frac{1}{2} \times 500 \times 0{,}5^2 = -62{,}5\,J$ $\qquad (W_{arq} = -W_{mola})$

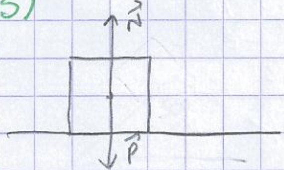
$W_{arq} = 62{,}5\,J$

c)

$m = 100g$

$W = \frac{1}{2}mv^2 \Leftrightarrow v^2 = \frac{2 \times 62{,}5}{0{,}100} \Leftrightarrow v = 35{,}4\,m/s$

5)



$v = 100\,Km/h = \frac{100 \times 10^3}{60 \times 60} = 27{,}78\,m/s$

$\Delta x = 150\,m$

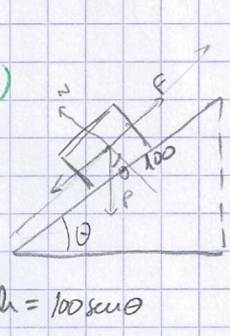
a) $v_f = 0$

$W = -\frac{1}{2}mv_i^2 = -\frac{1}{2} \times 5000 \times 27{,}78^2 = -1929321\,J$

$W = F \cdot \Delta x \cdot \cos(180°)$

$-1929321 = F \cdot 150 \cdot (-1) \Leftrightarrow F = 12\,862{,}14\,N = 1{,}29 \times 10^4\,N$

→ b)



$\Delta h = 100 \operatorname{sen}\theta$

$E_c + E_{pG} = 0$

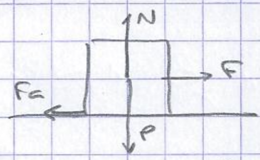
$-\frac{1}{2}mv^2 + mg\Delta h = 0$

$-\frac{1}{2} \times 5000 \times 27{,}78^2 + 5000 \times 9{,}8 \times \Delta h = 0$

$\Rightarrow \theta = 23{,}19°$

6) $m_c = 75 kg$ $V = 36 km/h$ $\Delta x = 150 m$

$m_B = \frac{15 kg}{90}$



$\vec{F} = -\vec{F_a}$

a) $F = ma$

$W = -\frac{1}{2} m v^2$ e $W = F_a . \Delta x . \cos(180)$

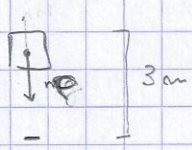
$W = -\frac{1}{2} \times 90 \times \left(\frac{36 \times 10^{+3}}{60 \times 60}\right)^2 = -4500$

$-4500 = F_a . 150 . (-1) \Leftrightarrow F_a = 30 N$

b) $P = F . V . \cos \theta°$

$P = 30 . 10 . \cos 0° = 300 W$

7) $m = 10 g$ $W = -\frac{1}{2} m v^2$



$\Delta h = 3 m$

$\Delta y = 0{,}03 m$

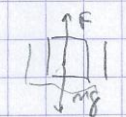
$v_f = 0$

$a = g \; m/s^2$

$v = \cancel{v_0}^{0} + gt$

$x = x_0 + \cancel{v_0 t}^{0} + \frac{1}{2} g t^2$

$3 = \frac{1}{2} \times 9{,}8 \times t^2 \Leftrightarrow t = 0{,}78 s$



logo $v = 9{,}8 \times 0{,}78 = 7{,}64 m/s$

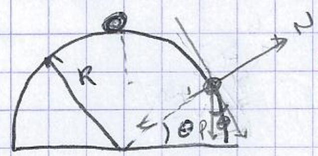
l, $W = -\frac{1}{2} \times 10 \times 10^{-3} \times 7{,}64^2$

$W = -0{,}29 J$

$W = F . \Delta y . \cos(180°) \Leftrightarrow -0{,}29 = F . 0{,}03 \times (-1)$

$\Leftrightarrow F = 9{,}7 N$

8)



a) $\begin{cases} N = m\frac{v^2}{R} \\ P \operatorname{sen}\theta = N \end{cases}$ $\cancel{m} g \operatorname{sen}\theta = \cancel{m}\frac{v^2}{R}$

$\operatorname{sen}\theta = \frac{v^2}{Rg}$

Conservação:

$E_c + E_{pG} = 0$

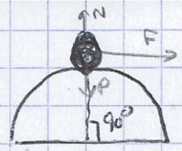
$\frac{1}{2}\cancel{m}v_i^2 - \frac{1}{2}\cancel{m}v_f^2 + \cancel{m}gh_i - \cancel{m}gh_f = 0$

$-\frac{1}{2} v_f^2 + gR - gR\operatorname{sen}\theta = 0 \Rightarrow v_f^2 = 2(gR - gR\operatorname{sen}\theta)$

$\operatorname{sen}\theta = \frac{2g\cancel{R}(1 - \operatorname{sen}\theta)}{\cancel{Rg}} \Leftrightarrow \operatorname{sen}\theta = 2 - 2\operatorname{sen}\theta$

$\Leftrightarrow \operatorname{sen}\theta = \frac{2}{3} \Rightarrow \theta \simeq 41{,}8°$

(3) 3)

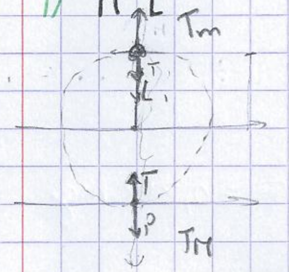


$N = \frac{mv^2}{R} \Leftrightarrow \cancel{m}g = \cancel{m}\frac{v^2}{R}$

$\Leftrightarrow v^2 = gR$

$\Leftrightarrow v = \sqrt{gR}$ m/s

9) M L



a) $\begin{cases} T_m = F_m - P \\ T_M = F_M + P \end{cases}$

$T_M - T_m = F_M - F_m + P + P$

$= M\frac{v_M^2}{L} - M\frac{v_m^2}{L} + 2Mg$

$= \frac{M}{L}(v_M^2 - v_m^2) + 2Mg$

$= \frac{M}{\cancel{L}} \times 4g\cancel{L} + 2Mg$

$= 6Mg$ ✓

$E_{M_i} = E_{M_f}$

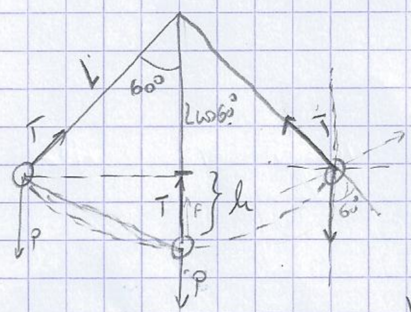
$\frac{1}{2}\cancel{M}(v_M^2 - v_m^2) = \cancel{M}g\,2L$

$v_M^2 - v_m^2 = 4gL$

b) $a = \frac{v^2}{L} \Leftrightarrow v^2 = aL \Leftrightarrow v = \sqrt{gL}$ quando $a = g$

10) $m = 50g$ $l = 1\,m$ $\theta = 60°$

a)



$\boxed{\text{Pela vertical}}$

$E_{M_i} = E_{M_f}$

$\frac{1}{2}m(v_f^2 - v_i^2) = mgh$, $v_i = 0$

$\frac{1}{2}\cancel{m}v^2 = \cancel{m}g(L - L\cos 60°)$

$v^2 = 2 \times 9{,}8 \times (1 - 1 \times 0{,}5)$

$v^2 = 9{,}8$

$T - P = F$

$T = F + P$

$= m\frac{v^2}{L} + mg$

$= 0{,}05v^2 + 0{,}49$

$= 0{,}05 \times 9{,}8 + 0{,}49$

$= 0{,}98N$

$\boxed{\text{Pela extremidade}}$ $T = P\cos 60° = 0{,}05 \times 9{,}8 \times 0{,}5 = 0{,}245N$

extremidade $v = 0$

11) $\begin{cases} P - \cancel{T} = F \\ \cancel{T} - P\,\text{sen}\,30° = F \end{cases}$ $\begin{cases} P(1 - \text{sen}\,30°) = 2F \end{cases}$

$2F = 0{,}5\,mg$ (N)

$F = 0{,}25\,mg$

$W = F \cdot \Delta y \cdot \cos(0°)$ $\wedge$ $W = \frac{1}{2}mv^2$

$W = 0{,}25\,mg \cdot 1 \cdot 1$

$0{,}25\,\cancel{m}g = \frac{1}{2}\cancel{m}v^2$

$v = \sqrt{0{,}5\,g}$

$= 2{,}21$ m/s

b) $\mu_c = 0,1$

$$\begin{cases} P - T = F \\ T - P\,sen\theta - F_a = F \end{cases} \qquad \begin{cases} P(1 - sen30°) - F_a = 2F \end{cases}$$

$N = P\cos 30°$

$0,5P - \mu_c N = 2F$

$0,5P - 0,1 \cdot P\cos 30° = 2F$

$0,5P - 0,087P = 2F$

$0,41P = 2F \Leftrightarrow F = 0,21 \times mg$

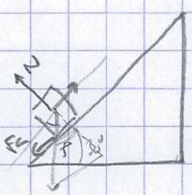
$W = F \cdot \Delta x \cdot \cos 0$ mas $W = \frac{1}{2}mv^2$

$W = 0,21mg$

$0,21\cancel{m}g = \frac{1}{2}\cancel{m}v^2$

$v^2 = 4,116 \Leftrightarrow v = 2,03$ m/s

12) $m = 0,2$ kg $\theta = 30°$ $v_i = 12$ m/s $\mu = 0,16$ $\Delta x = ?$



$W(F_{NC}) = Em_f - Em_i$

$= W(F_a)$

$= \mu \cdot N \cdot \Delta x \cdot \cos 180°$

$= -0,16 \cdot P\cos 30° \cdot \Delta x$

$= -0,27\,\Delta x$

$sen 30° = \frac{\Delta h}{\Delta x} \Leftrightarrow$

$\Leftrightarrow \Delta x = 2\Delta h$

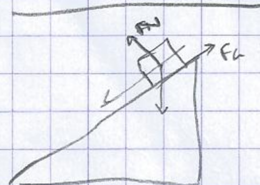
$Em_f - Em_i = \frac{1}{2}mv_f^2 + mgh - \frac{1}{2}mv_i^2 - mgh_0$ $v_f = 0$ $v_i = 12$ m/s $\Delta h = 0,5\,\Delta x$

$-0,27\Delta x = -\frac{1}{2}mv_i^2 + mgh$

$-0,27\Delta x = -14,4 + 0,98\,\Delta x$

$\Delta x = \frac{14,4}{1,25} = 11,5$ m

voltar à base



$W(F_{NC}) = W(F_a)$

$= -0,27\Delta x$

$= -3,12$ N

$-3,12 = \frac{1}{2}mv_f^2 + mg\cancel{h}^{\,0} - \cancel{\frac{1}{2}mv_i^2}^{\,0} - mgh_0$

$-3,12 = \frac{1}{2}mv_f^2 + mg \times 0,5\,\Delta x$

$-3,12 = 0,1v_f^2 + 11,27$

$v_f^2 = 81,5$

$v_f = 9,0$ m/s

(4) 13) $m = 1\,kg$ $\quad \vec{F} \quad U(x,y) = x^2 + y^2$

a) $\vec{F}(x,y)$

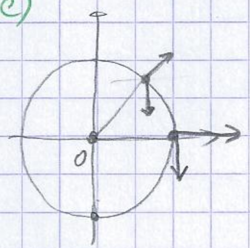
$$F_x = -\frac{dE_p}{dx} = -2x$$

$$F_y = -\frac{dE_p}{dy} = -2y$$

$$\vec{F} = -2x\hat{i} - 2y\hat{j}$$

b) $\vec{F} = \vec{0} \Rightarrow \begin{cases} -2x = 0 \\ -2y = 0 \end{cases} \Leftrightarrow \begin{cases} x = 0 \\ y = 0 \end{cases} \quad (0,0)$

c)



$$F_{ep} = \sqrt{4x^2 + 4y^2}$$

$$F_{ep} = \sqrt{4(x^2+y^2)}$$

$$F_{ep} = 2\sqrt{x^2+y^2}$$

$$F_{ep} = 2\sqrt{r^2}$$

$$F_{ep} = 2r$$

$x = r\cos\theta$

$y = r\,\text{sen}\,\theta$

$U(x,y) = r^2$

$2 = E_c + E_p$

$2 = \frac{1}{2}mv^2 + r^2$

$2 = \frac{1}{2} \times 2r^2 + r^2$

$2 = 2r^2$

$r^2 = 1$

$r = 1\,m$

$F = ma$

$2r = ma$

$a = 2r$

$\frac{v^2}{r} = 2r$

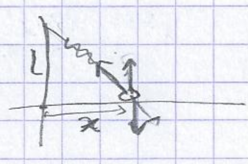
$v^2 = 2r^2$

Movimento circular

14) $m = 1\,kg$

L

K



a = alongamento

$$E_p = \frac{1}{2}k a^2$$

a) $d^2 = L^2 + x^2$

$d = \sqrt{L^2 + x^2}$

$a = d - l$

$a = \sqrt{L^2+x^2} - L$

$a^2 = L^2 + x^2 - 2L\sqrt{L^2+x^2} + L^2$

logo, $E_p = \frac{1}{2}k\left(x^2 + 2L^2 - 2L\sqrt{L^2+x^2}\right)$

$\left(\left(L^2+x^2\right)^{1/2}\right)' =$

$= \frac{1}{2} \times 2x\left(L^2+x^2\right)^{-1/2}$

$= \frac{x}{\sqrt{L^2+x^2}}$

b)

$$F(x) = -U'(x) = -\frac{1}{2}k\left(2x - 2L \times \frac{x}{\sqrt{L^2+x^2}}\right)$$

$$= -kx\left(1 - \frac{L}{L^2+x^2}\right)$$

c) $F(0) = 0$ //