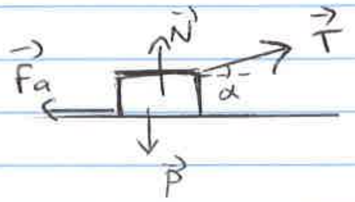
Série 3 – Física Geral

1. $W = \int_A^B \vec{F}\cdot d\vec{r} = \int_0^{5.0} 4.0\, x\, dx = 50\ J.$

(Note que F_y não realiza trabalho, pq o deslocamento é ao longo de x).

2.



$|\vec{F_a}| = \mu |\vec{N}|$

$\vec{P}$ e $\vec{N}$ não realizam trabalho, pq são $\perp$s ao deslocamento.

$W = \sum W_{\vec{F_a}} + W_{\vec{T}}$

Cálculo de $\vec{T}$ e de $\vec{N}$

$\vec{P} + \vec{N} + \vec{F_a} + \vec{T} = m\vec{a} = 0$ ($v = cte$).

$$\begin{cases} -mg + N + T\sin\alpha = 0 \\ T\cos\alpha - \mu N = 0 \end{cases} \Rightarrow \begin{cases} T = \mu mg/(\cos\alpha + \mu\sin\alpha) \\ N = \dfrac{T\cos\alpha}{\mu}. \end{cases}$$

a) $T = 79\ N$ e

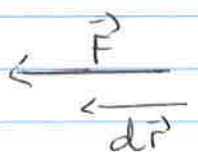
b) $W_{\vec{T}} = \int_{x_i}^{x_f} T\cos\alpha\, dx = T\cos\alpha\,(x_f - x_i) = 1.5\times10^2\ J.$

c) 0.

d) 0.

e) $W_{\vec{F_a}} = -W_{\vec{T}}$ ($v = cte$).

3.

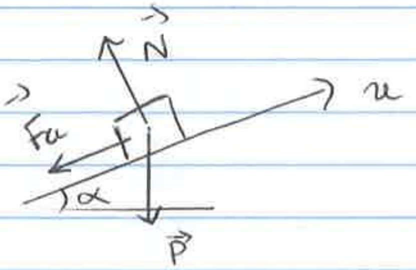


$W = \frac{1}{2}kx_f^2$

a) $F = kx$ $\quad k = \dfrac{230}{0{,}400} = 575\ N/m.$

b) $W = \int_0^{x_f} kx\,dx = \frac{1}{2} k x_f^2 = \underline{46\ J}$

4.



a) $W_{\vec{P}} + \underbrace{W_{\vec{N}}}_{0} + W_{\vec{F_a}} = \frac{1}{2}(\underbrace{v_f^2}_{0} - v_i^2)$

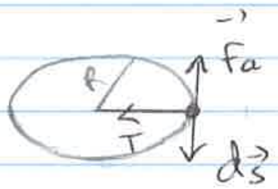
$W_{\vec{P}} + W_{\vec{F_a}} = \int_0^d (-mg\sin\alpha - F_a)\,dx$

$= (-mg\sin\alpha - F_a)\,d = -\frac{1}{2} m v_i^2$

$d = \frac{m v_i^2}{2(mg\sin\alpha + f_a)} = \underline{4{,}5\ m}$

b) $F_a > mg\sin\alpha$, pelo que não escorrega!
muda de sinal.

5.



$\vec{F_a}$ e $\vec{ds}$ tangente à trajectória

$\vec{N}$ e $\vec{P}$ ⊥ ao plano (trajectória)

$W_{\vec{P}} = 0$ e $W_{\vec{N}} = 0$.

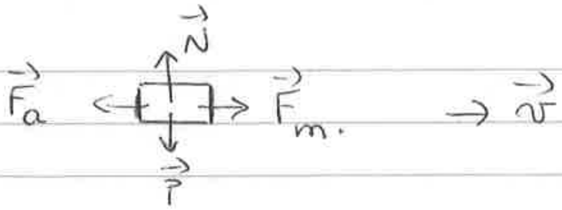
$\vec{T}$ é perpendicular à trajectória (no plano)

$W_T = 0$.

$W_{fa} = \int -F_a\,ds = -\mu N \int ds = -\mu mg \times \underbrace{2\pi R}_{\text{perímetro de circunferência}}$.

$W_{Fa} = \underline{-12 \times 10\ J}$.

6.



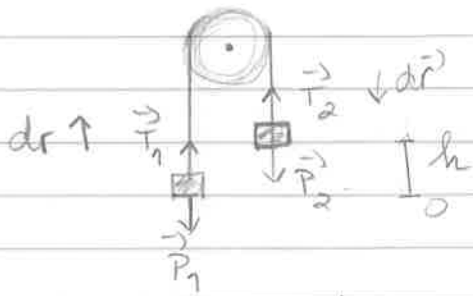
a) $W_{\vec{P}} = 0$ $\quad W_{\vec{N}} = 0$ $\quad W_{\vec{F_a}} + W_{\vec{F_m}} = 0$ pq $v = cte$.

$$W_{\vec{F_m}} = - W_{\vec{F_a}} = \mu N \Delta x = \mu m g \Delta x$$

$$P = \frac{W_{\vec{F_m}}}{\Delta t} = \mu m g \frac{\Delta x}{\Delta t} = \mu m g v = 3,9 \times 10^3 \text{ W}.$$

b) $W_{F_m} = \int P \, dt = P \Delta t = 7,0 \times 10^5 \text{ J}.$

7.



$$W_{\vec{P_1}} + W_{\vec{T_1}} = \Delta E_c^1 \qquad W_{\vec{P_2}} + W_{\vec{T_2}} = \Delta E_c^2$$

Mas $W_{\vec{T_1}} = - W_{\vec{T_2}}$ e

$$W_{\vec{P_1}} + W_{\vec{P_2}} = \Delta E_c^1 + \Delta E_c^2$$

$\vec{P}$ conservativa $\quad W_{\vec{P_1}} = -\Delta E_p^1$ e $W_{\vec{P_2}} = -\Delta E_p^2$

$$\therefore \Delta E_c^1 + \Delta E_c^2 + \Delta E_p^1 + \Delta E_p^2 = 0$$

$$E_t = E_c^1 + E_p^1 + E_c^2 + E_p^2 = \text{const}.$$

$$E_{ti} = \frac{1}{2} m_1 \underbrace{v_{1i}^2}_{0} + m_1 g \underbrace{h_{1i}}_{0} + \frac{1}{2} m_2 \underbrace{v_{2i}^2}_{0} + m_2 g \underbrace{h_{2i}}_{h} = m_2 g h.$$

$$E_{tf} = \frac{1}{2} m_1 \underbrace{v_{1f}^2}_{v_f} + m_1 g \underbrace{h_{1f}}_{h} + \frac{1}{2} m_2 \underbrace{v_{2f}^2}_{v_f} + m_2 g \underbrace{h_{2f}}_{0}$$

$$E_{tf} = \frac{1}{2}(m_1+m_2)v_f^2 + m_1 g h$$

$$E_{ti} = E_{tf} \Rightarrow v_f = \sqrt{\frac{2(m_2-m_1)gh}{m_1+m_2}} = 4.4\,ms^{-1}$$

b)

$$W_{\vec{P}_1} = \Delta E_c^1 \qquad \Delta E_c^1 + \Delta E_p^1 = 0$$

$$E_t^1 = \frac{1}{2}m_1 v_1^2 + mgh_1 = \text{const.}$$

inicial/ $E_t^1 = \frac{1}{2}m_1 v_f^2 + m_1 g h$

final/ $E_t^1 = 0 + m_1 g h_{max}$

igualando $\frac{1}{2}m_1 v_f^2 + m_1 g h = m_1 g h_{max}$

$$h_{max} = h + \frac{v_f^2}{2g} = \frac{2m_2}{(m_1+m_2)}h = 5.0\,m$$

8. $m_1 = 3.0\,kg.$ $\qquad W_{\vec{P}_1} + W_{\vec{N}} + W_{\vec{T}_1} + W_{\vec{F}a} = \Delta E_c^1$

$m_2 = 5.0\,kg$ $\qquad W_{\vec{P}_2} + W_{\vec{T}'_1} = \Delta E_c^2$

$$W_{\vec{T}_1} = -W_{\vec{T}'_1}$$

$$\underset{0}{W_{\vec{P}_1}} + \underset{0}{W_{\vec{N}}} + W_{\vec{P}_2} + W_{\vec{F}a} = \Delta E_c^1 + \Delta E_c^2$$

$$W_{\vec{P}_2} + W_{\vec{F}a} = \frac{1}{2}(m_1+m_2)v_f^2$$

$W_{\vec{P}_2} = -\Delta E_p^2$ e $F_a = \mu m_1 g \quad \therefore W_{\vec{F}a} = -\mu m_1 g h$

$$-\Delta E_p^2 = m_2 g h$$

$$m_2 g h - \mu m_1 g h = \frac{1}{2}(m_1+m_2)v_f^2$$

$$v_f = \sqrt{\frac{2(m_2-\mu m_1)gh}{m_1+m_2}} = 3.7\,m/s.$$

9.

$$\underbrace{W_{\vec{P}}}_{-\Delta E_p} + \underbrace{W_{\vec{N}}}_{0} = \Delta E_c$$

$$\Delta E_p + \Delta E_c = 0 \qquad E_c + E_p = cte$$

inicial. $E = \frac{1}{2} m \underbrace{v_i^2}_{0} + m g h_i = m g h$

final $E = \frac{1}{2} m v_A^2 + m g \underbrace{h_A}_{2R} = \frac{1}{2} m v_A^2 + 2 m g R.$

igualando.

$$m g h = \frac{1}{2} m v_A^2 + m g 2R.$$

$$v_A = \sqrt{3{,}0 g R} = \sqrt{29.4 R} \quad m/s.$$

10. No plano AB de comprimento l
Na superfície $B \to C$

$$\underbrace{W_{\vec{N}}}_{0} + \underbrace{W_{\vec{P}}}_{-\Delta E_p} + W_{\vec{F_a}} = \Delta E_c.$$

$$\Delta E_c = -\Delta E_p + W_{\vec{F_a}}$$

comp. plano.

$A \to B$ $\quad W_{\vec{F_a}} = \int_A^B F_a \, dx = -F_a l = -\mu m g \cos\theta \, l$

mas $l = \frac{h}{\sin\theta}$ $\quad \therefore \quad W_{\vec{F_a}} = -\mu m g h \cot\theta$

$$\frac{1}{2} m v_B^2 - \frac{1}{2} m \underbrace{v_A^2}_{0} = -(m g \underbrace{h_B}_{0} - m g \underbrace{h_A}_{h}) - \mu m g h \cot\theta.$$

$$\frac{1}{2} m v_B^2 = m g h (1 - \mu \cot\theta)$$

$B \to C$ $\quad W_{\vec{F_a}} = -F_a d = -\mu m g d$

$$\underbrace{W_{\vec{N}}}_{0} + \underbrace{W_{\vec{P}}}_{0} + W_{\vec{F_a}} = \Delta E_c$$

$$\Delta E_c = W_{\vec{F_a}}$$

$$\frac{1}{2} m \underbrace{v_C^2}_{0} - \frac{1}{2} m v_B^2 = -\mu m g d$$

$$d = h\left(\frac{1}{\mu} - \cot\theta\right) = 1{,}9\,m.$$

11. Até bater na mola A → B.

$$\underbrace{W_{\vec{P}}}_{-\Delta E_p} + \underbrace{W_{\vec{N}}}_{0} = \Delta E_c$$

$$E = \frac{1}{2} m v^2 + m g h = \text{const.} \qquad h = 0 \text{ em B}$$

$$A: \frac{1}{2} m \underbrace{v_A^2}_{0} + m g \underbrace{h_A}_{d \sin\theta} = m g d \sin\theta$$

$$B: \frac{1}{2} m v_B^2 + m g \underbrace{h_B}_{0} = \frac{1}{2} m v_B^2$$

$$\therefore \quad m g d \sin\theta = \frac{1}{2} m v_B^2 \quad *$$

$$B \to C \quad \underbrace{W_{\vec{P}}}_{-\Delta E_p} + \underbrace{W_{\vec{N}}}_{0} + \underbrace{W_{\vec{F}_m}}_{-\Delta E_{pm}.} = \Delta E_c$$

$$E = \frac{1}{2} m v^2 + m g h + \frac{1}{2} k x^2 = \text{const.}$$

$$B: \frac{1}{2} m v_B^2 + 0 + 0 = \frac{1}{2} m v_B^2 \quad (x = 0 \text{ eq/. mola}).$$

$$C: \frac{1}{2} m \underbrace{v_C^2}_{0} + m g h_C + \frac{1}{2} k x^2$$

mas $h_C = -x \sin\theta$ (trigonometria).

$$C: -m g x \sin\theta + \frac{1}{2} k x^2$$

igualando B e C. $\frac{1}{2} m v_B^2 = -m g x \sin\theta + \frac{1}{2} k x^2$

igualando a * fica

$$m g d \sin\theta = -m g x \sin\theta + \frac{1}{2} k x^2$$

$$d = -x + \frac{k x^2}{2 m g \sin\theta} = 0{,}34\,m$$

12. a) $W_{\vec{F}} = -FD \qquad W_{\vec{T}} = 0 \qquad \vec{T} \perp$ desloc.

$$W_{\vec{P}_J} = -\Delta E_p = -m_J g (h_f - h_i)$$

$$h_f = L - L\cos\phi_0 \qquad h_i = L - L\cos\theta_0$$

$$W_{\vec{P}_J} = m_J g L (\cos\phi_0 - \cos\theta_0).$$

$$W_{\vec{F}} + W_{\vec{P}_J} = m_J g L (\cos\phi_0 - \cos\theta_0) - FD = \Delta E_c =$$

$$= \frac{1}{2} m_J (v_f^2 - v_i^2)$$

$$v_{i,min}^2 = \frac{2FD}{m_J} - 2gL(\cos\phi_0 - \cos\theta_0) \qquad \underset{0}{\overset{\shortparallel}{}} \text{ para } v_{i,min}.$$

$$v_{i,min} = 6.02 \text{ m s}^{-1}$$

b) $\underbrace{W_{\vec{P}}}_{-\Delta E_p} + \underbrace{W_{\vec{T}}}_{0} + W_{\vec{F}} = \Delta E_c.$

$$W_{\vec{P}} = -(m_T + m_J) g (h_f - h_i)$$

$$= (m_T + m_J) g L (\cos\theta_0 - \cos\phi_0)$$

$W_{\vec{F}} = +FD$ (vento a favor).

$$(m_T + m_J) g L (\cos\theta_0 - \cos\phi_0) + FD = \frac{1}{2}(m_T + m_J)(\underbrace{v_f^2}_{0} - v_i^2)$$

$$v_{i,min} = \sqrt{\frac{-2FD}{m_T + m_J} + 2gL(\cos\phi_0 - \cos\theta_0)} = 12.2 \text{ m/s}.$$