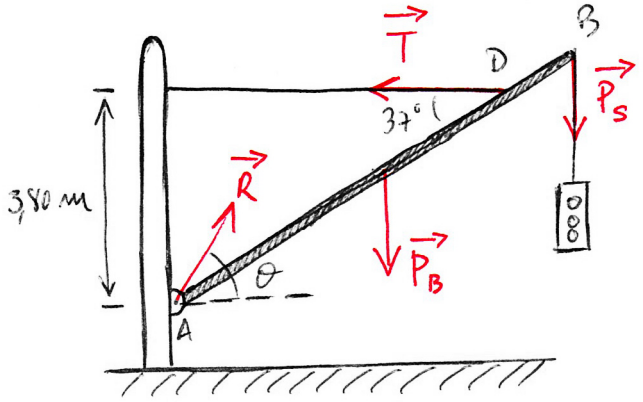
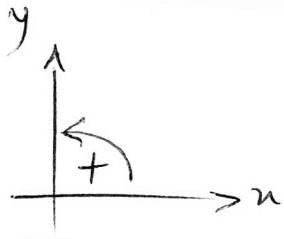
1.





$\ell = 7{,}5\ m$

$m_B = 8\ Kg$

$m_S = 12\ Kg$

$$\begin{cases} \sum F_x = 0 \\ \sum F_y = 0 \\ \sum M_A = 0 \end{cases} \quad \begin{cases} -T + R_x = 0 \\ R_y - P_B - P_S = 0 \\ -\frac{\ell}{2}\cos 37^\circ P_B - \ell \cos 37^\circ P_S + 3{,}80\,T = 0 \end{cases}$$

$$\begin{cases} R_x = T \\ R_y = m_B g + m_S g = 8 \times 9{,}8 + 12 \times 9{,}8 = 196 \\ 3{,}80\,T = 3{,}75 \times \cos 37^\circ \times 8 \times 9{,}8 + 7{,}5 \times \cos 37^\circ \times 12 \times 9{,}8 = 939{,}2 \end{cases}$$

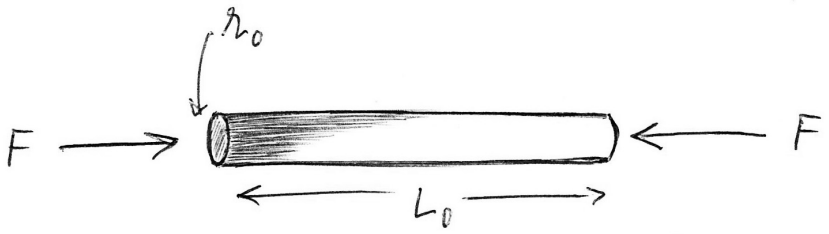
$$\begin{cases} R_x = 247{,}2\ N \\ R_y = 196\ N \\ T = 247{,}2\ N \end{cases} \qquad R = \sqrt{R_x^2 + R_y^2} = \sqrt{247{,}2^2 + 196^2} = 315{,}5\ N$$

1.1 $T = 247{,}2\ N$

1.2 $\vec{R} = 247{,}2\,\hat{i} + 196\,\hat{j}\ (N)$, $\|\vec{R}\| = 315{,}5\ N$

$$tg\,\theta = \frac{196}{247{,}2} \Rightarrow \theta = 38{,}4^\circ$$

2.



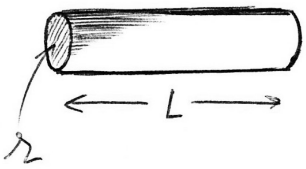
$L_0 = 1\ m$

$d_0 = 8\ cm$

$F = -1{,}0 \times 10^5\ N$

$Y = 1{,}0 \times 10^{10}\ N/m^2$

$\sigma = 0{,}35$



2.3 $B = \dfrac{Y}{3(1-2\sigma)}$

$B = \dfrac{1{,}0 \times 10^{10}}{3(1-2\times 0{,}35)} =$

$= 1{,}11 \times 10^{10}\ Pa$

2.1 $\dfrac{F}{A} = Y \dfrac{\Delta L}{L_0} \Leftrightarrow \Delta L = \dfrac{F L_0}{A Y} \Leftrightarrow$

$\Delta L = \dfrac{-1{,}0 \times 10^5 \times 1}{\pi \times 0{,}04^2 \times 1{,}0 \times 10^{10}} = -1{,}989 \times 10^{-3}\ m = -1{,}989\ mm$

2.2 $\Delta V = V - V_0 =$

$= \pi r^2 L - \pi r_0^2 L_0 =$

$= \pi (r^2 L - r_0^2 L_0) =$

$= \pi \left[(r_0 + \Delta r)^2 (L_0 + \Delta L) - r_0^2 L_0 \right]$

$L = L_0 + \Delta L$

$r = r_0 + \Delta r$

$\sigma = -\dfrac{\delta_T}{\delta_L} = -\dfrac{\frac{\Delta r}{r_0}}{\frac{\Delta L}{L_0}}$

$\Delta r = -\sigma \dfrac{\Delta L}{L_0} r_0$

$\therefore \Delta r = -0{,}35 \times \dfrac{-1{,}989 \times 10^{-3}}{1} \times 0{,}04 =$

$= 2{,}7846 \times 10^{-5}\ m$

$\therefore \Delta V = \pi \left[(0{,}04 + 2{,}7846 \times 10^{-5})^2 \times (1 - 1{,}989 \times 10^{-3}) - 0{,}04^2 \times 1 \right]$

$= -3{,}01 \times 10^{-6}\ m^3$

3. $m = 1300\ kg$

$F_g = 2800\ N$

3.1 $$F_g = G\frac{M_T m}{(R_T+h)^2} \Leftrightarrow (R_T+h)^2 = \frac{G M_T m}{F_g}$$

$$R_T + h = \sqrt{\frac{G M_T m}{F_g}} \Leftrightarrow h = \sqrt{\frac{G M_T m}{F_g}} - R_T$$

$$h = \sqrt{\frac{6{,}67\times10^{-11}\times 5{,}98\times10^{24}\times 1300}{2800}} - 6{,}38\times10^{6}$$

$$h = 7{,}23\times10^{6}\ m$$

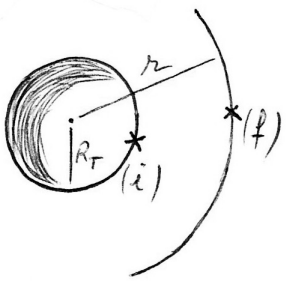
3.2 $$\Delta E = E_f - E_i = E_{orb} - E_{p,T} =$$

$$= \left(-G\frac{M_T m}{2r}\right) - \left(-G\frac{M_T m}{R_T}\right) =$$

$$= G M_T m\left(-\frac{1}{2r} + \frac{1}{R_T}\right) =$$

$$= 6{,}67\times10^{-11}\times 5{,}98\times10^{24}\times 1300\left(\frac{-1}{2\times1{,}36\times10^{7}} + \frac{1}{6{,}38\times10^{6}}\right)$$

$$= 6{,}22\times10^{10}\ J = 62{,}2\ GJ$$



i) Estado inicial. Só tem energia potencial gravítica

f) Estado final. tem a energia correspondente à órbita que ocupa.

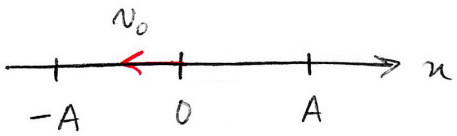
4.

$K = 120\ N/m$

$T = 0{,}5\ s$

$x_0 = 0$

$v_0 = -1\ m/s$



4.1

$$\omega^2 = \frac{K}{m} \Leftrightarrow m = \frac{K}{\omega^2} = \frac{120}{(4\pi)^2} \cong 0{,}76\ Kg$$

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{0{,}5} = 4\pi\ rad/s$$

4.2

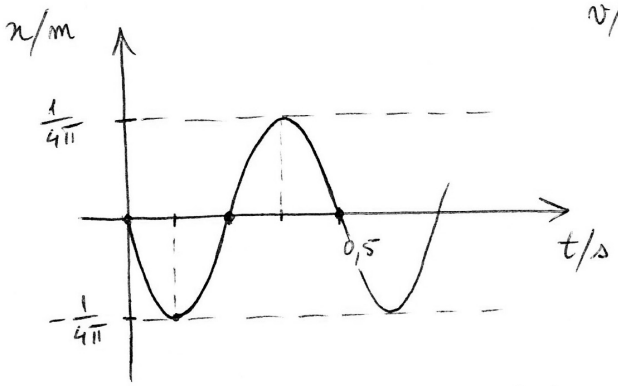
$$x = A\cos(\omega t + \phi)\ ,\quad v = -A\omega\sin(\omega t + \phi)$$

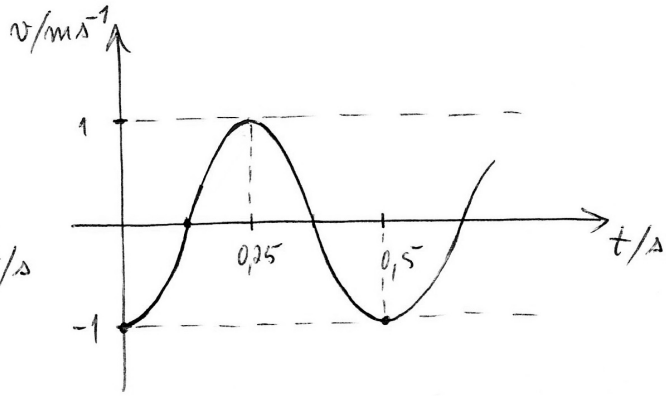
$$A = \sqrt{x_0^2 + \left(\frac{v_0}{\omega}\right)^2} = \sqrt{0^2 + \left(\frac{-1}{4\pi}\right)^2} = \frac{1}{4\pi} \approx 0{,}0796\ m$$

$$v_0 = -A\omega\sin\phi$$

$$-1 = -\frac{1}{\cancel{4\pi}} \times \cancel{4\pi}\sin\phi \Rightarrow \sin\phi = 1 \Rightarrow \phi = \frac{\pi}{2}$$

$$\therefore\ x(t) = \frac{1}{4\pi}\cos\left(4\pi t + \frac{\pi}{2}\right)\ ,\quad v(t) = -\sin\left(4\pi t + \frac{\pi}{2}\right)$$





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