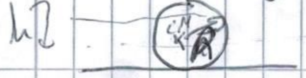
$\vec{\tau}\ \vec{r} \times \vec{F}$

② Determinar h de modo que a bola role sen escorregar



$\hookrightarrow \tau = r \cdot F \cdot sen(\vec{r}, \vec{F})$

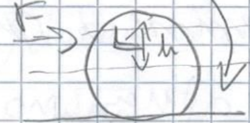
$\vec{\tau} \neq \vec{0}$

$\Sigma \vec{\tau}_i = I \alpha$

$I_{CM} = \frac{2}{5} m R^2$

sfera

$\alpha = \frac{a}{R}$



$\tau_F = -h \cdot F \, sen(90)$ 1

$\boxed{\tau_F = -h F}$

$\tau_F = I_{CM} \cdot \alpha$

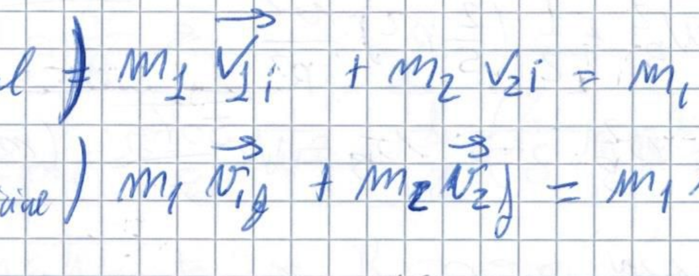
$\boxed{\tau_F = \frac{2}{5} m R^2 \times \left(-\frac{a}{R}\right)}$

$-h \cdot F = \frac{2}{5} m R a$

$h = \frac{2}{5} \frac{m R a}{F}$ — 2ª lei Newton $h = \frac{2 m R a}{5 m a} \rightarrow h = \frac{2R}{5}$ ///

PN 26/10/18

③ (3.1)



$\Delta \vec{p} = \vec{0}$

$\Delta (m \vec{v}) = \vec{0}$

$\frac{v_{1f}}{v_{2f}} = ?$

inicial $\big)$ $m_1 \vec{v}_{1i} + m_2 v_{2i} = m_1 \vec{v}_{1i}$

final $\big)$ $m_1 \vec{v}_{1f} + m_2 \vec{v}_{2f} = m_1 \vec{v}_{1i}$

$$\begin{cases} x: & m_1 v_{1xi} = m_1 v_{1fx} + m_2 v_{2fx} \\ & \Rightarrow \\ y: & 0 = m_1 v_{1fy} + m_2 v_{2fy} \end{cases}$$

$$\Rightarrow \begin{cases} m_1 v_{1i} = m_1 v_{1f} \cos\theta_1 + m_2 v_{2f} \cos\theta_2 \\ 0 = m_1 v_{1f} \operatorname{sen}\theta_1 - m_2 v_{2f} \operatorname{sen}\theta_2 \end{cases}$$

$$\to m_1 v_{1f} \operatorname{sen}\theta_1 = m_2 v_{2f} \operatorname{sen}\theta_2$$

$$\to \boxed{\frac{v_{1f}}{v_{2f}} = \frac{m_2 \operatorname{sen}\theta_2}{m_1 \operatorname{sen}\theta_1}}$$

b) $m_1 = m_2 = m$

$\theta_1 = 45^\circ$, $\theta_2 = 30^\circ$

Verificar se o choque é elástico

$$\boxed{\text{CHOQUE ELÁSTICO SE } \Delta E_c = 0}$$

$$\frac{v_{1f}}{v_{2f}} = \frac{m_2 \operatorname{sen}\theta_2}{m_1 \operatorname{sen}\theta_1} = \frac{\cancel{m} \operatorname{sen} 30^\circ}{\cancel{m} \operatorname{sen} 45^\circ}$$

$$v_{1f} = \frac{0{,}5}{\sqrt{2}/2} v_{2f}$$

$$v_{1f} = 0{,}7\, v_{2f}$$

$m_1 = m_2$

$$P_x \to m_1 v_{1i} = m_1 v_{1f} \cos\theta_1 + m_2 v_{2f} \cos\theta_2$$

$$v_{1i} = v_{1f} \cos 45^\circ + v_{2f} \cos 30^\circ$$

$$v_{1i} = 0{,}7\, v_{1f} + 0{,}86\, v_{2f} \leftarrow (1)$$

Se choque for elástico:

$$\frac{1}{2} m_1 v_{1i}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$$

$$v_{1i}^2 = v_{1f}^2 + v_{2f}^2$$

$$\Rightarrow ?$$

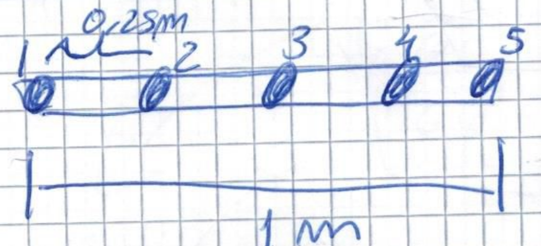
$v_{1f} = 0,7\, v_{2f}$

$v_{1f}^2 = 0,7^2 \cdot v_{2f}^2$

$v_{1i}^2 = v_{2f}^2 + 0,7 v_{2f}^2$

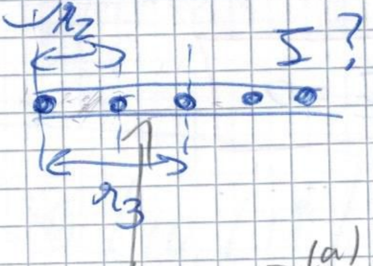
$v_{1i}^2 = v_{2f}^2 (1 + 0,7^2)$ Igualar a (1)

(3.2)



$m = 1\,kg \quad , \quad m_b = 0,2\,kg$

a)



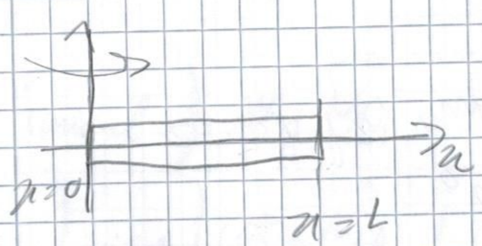
$I = \sum m_i r_i^2$

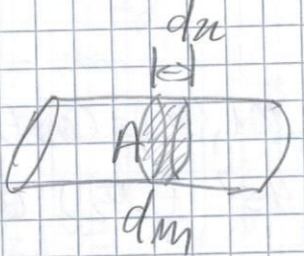
$I_T = I_b + I_1 + I_2 + I_3 + I_4 + I_5$

$\rightarrow I_T^{(a)} = I_b + I_2 + I_3 + I_4 + I_5$

$I_2 = m \cdot (0,25)^2$ $\qquad$ $I_4 = m (0,75)^2$

$I_3 = m (0,5)^2$ $\qquad$ $I_5 = m (1)^2$ $\qquad$ $kg \cdot m^{-2}$





$\rho = \frac{massa}{volume} = \frac{massa}{comprimento}$

$I_b = \sum_i m_i r_i^2$

$\rho = \frac{m_b}{L}$

$I_b = \int r^2\, dm$

$dm = \frac{m_b}{L}\, dx$

$I_b = \int r^2\, dm$

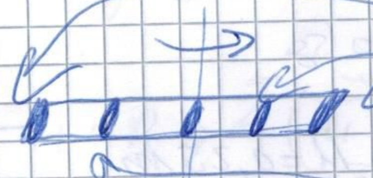
$I_b = \int_0^L x^2 \frac{m_b}{L}\, dx = \frac{m_b L^2}{2}$

b)

$$I_T^{(b)} = I_b + m\cdot 0{,}25^2 + m\cdot 0{,}25^2 + m\cdot 0{,}5^2 + m\cdot 0{,}75^2$$

$$I_b = \int_0^{L/4} \frac{x^2 m_b}{L}\,dx + \int_0^{3L/4} \frac{x^2 m_b}{L}\,dx \qquad L = 1\,m$$

c)



$$I_T^{(c)} = I_b + 0{,}25^2 m + 0{,}25^2 m + 0{,}5^2 m + 0{,}5^2 m$$

$$I_b = \int_0^{L/2} x^2 \frac{m_b}{L}\,dx + \int_0^{L/2} x^2 \frac{m_b}{L}\,dx$$

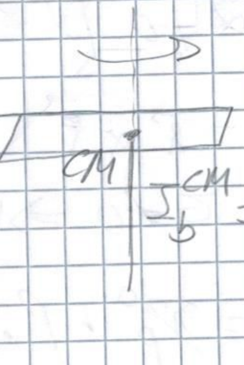
$$I_b = \frac{ML^2}{12}$$

d) Teorema de Steiner (Teorema de eixos paralelos)

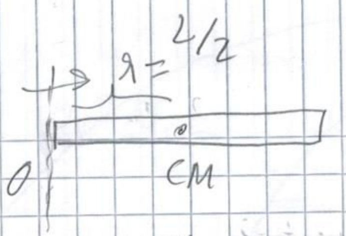
$$I = I_{CM} + MR^2$$

em relação a qualquer eixo de rotação

distância do CM ao eixo de rotação



$$I_b^{CM} = \frac{ML^2}{12}$$



Teorema de Steiner

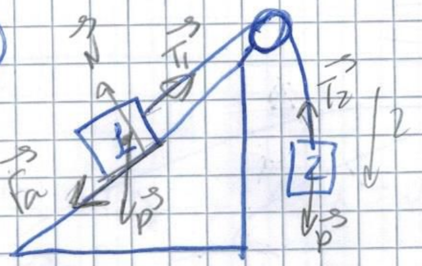
$I_T = I_b^0 + m\,(0,25^2 + 0,5^2 + 0,75^2$

$I_b^0 = I_b^{CM} + m_b \cdot r^2$

$I_b^0 = \frac{m_b L^2}{12} + \frac{m_b L^2}{4_{(3)}}$

$I_b^0 = \frac{4 m_b L^2}{12} = \frac{m_b L^2}{3}$

33



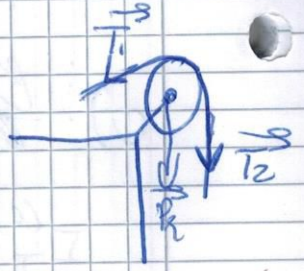
$m_1 = \cancel{15}\ 15\ kg$

$m_2 = 20\ kg$

roldana $R = 0,25\ m$

o bloco 1 sobe o plano com $a = 2\ m/s^2$

$\mu_c = 0,1$



$\overbrace{\sum \tau}^{\tau_R} = I \cdot \alpha$

$I_{roldana} = \frac{1}{2} m_{rolda} R^2$

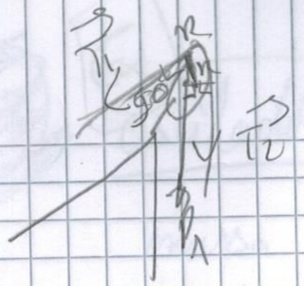
Se $m_{roldana} \neq 0 \Rightarrow I_{roldana} \neq 0$

Se $I_{roldana}$
Se $\alpha \neq 0$ $\Rightarrow \tau_R \neq 0$

$\vec{\tau} = \vec{r} \times \vec{F}$

$\Rightarrow$ Se $\tau \neq 0 \Rightarrow F \neq 0$

$\tau_p = \cancel{r_p}^0 \cdot P \cdot sen(\vec{r_p}, \vec{P})$



$1: \; T_1 - m_1 g \operatorname{sen}\theta - F_a = m_1 a_1$

$2: \; m_2 g - T_2 = m_2 a_2$

roldana: (só há rotação)

$\tau_{T_1} + \tau_{T_2} + \cancel{\tau_p}^{\,0} = \underline{I \cdot \alpha}$

$F_a = \mu N = \mu m_1 g \cos\theta$

$$T \begin{cases} T_1 - m_1 g \operatorname{sen}\theta - \mu m_1 g \cos\theta = m_1 a_1 \\ m_2 g - T_2 = m_2 a_2 \\ R - T_1 \cdot R \underbrace{\cancel{\operatorname{sen}}^{\,1}(\vec{T_1}, \vec{R})}_{90^\circ} - T_2 R \underbrace{\cancel{\operatorname{sen}}^{\,1}(\vec{T_2}, \vec{R})}_{90^\circ} = I \cdot \alpha \end{cases}$$

$a_1 = a_2 = a$

$\alpha = \dfrac{a}{R}$

$$\begin{cases} T_1 - m_1 g \operatorname{sen}\theta - \mu m_1 g \cos\theta = m_1 \cdot a \\ m_2 g - T_2 = m_2 a \\ T_1 \cdot R - T_2 \cdot R = I \dfrac{a}{R} \longrightarrow \boxed{(T_1 - T_2)\, 0{,}25 = I \cdot \dfrac{2}{0{,}25}} \end{cases}$$

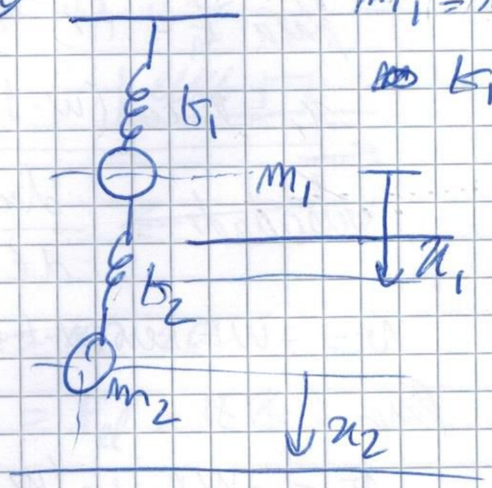
$$\begin{cases} T_1 - 15 \times 9{,}8 \times \dfrac{\sqrt{2}}{2} - 0{,}1 \times 15 \times 9{,}8 \cdot \dfrac{\sqrt{2}}{2} = 15 \times 2 \\ 20 \times 9{,}8 - T_2 = 20 \times 2 \end{cases}$$

$\longrightarrow T_2 = 160 \; (N)$

$T_1 = 85{,}5 \; (N)$

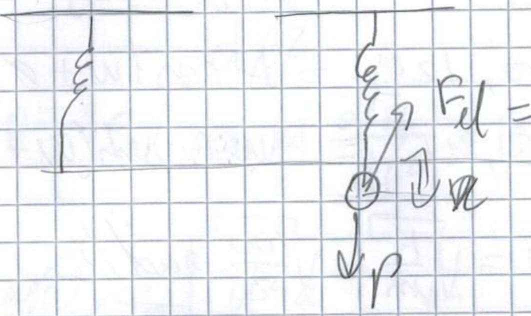
3.4

$$m_1 = m_2 \equiv m$$
$$k_1 = k_2 \equiv k$$



$$1: \; m\frac{d^2x_1}{dt^2} + kx_1 + kx_1 - kx_2 = 0$$

$$2: \; m\frac{d^2x_2}{dt^2} + kx_2 - kx_1 = 0$$



Considerando

$1: \; x_1 = X_1 \cos(\omega t)$

$2: \; x_2 = X_2 \cos(\omega t)$

$$\begin{cases} [-m\omega^2 + 2k]\cdot X_1 - kX_2 = 0 \\ -kX_1 + [-m\omega^2 + k]X_2 = 0 \end{cases}$$

$$m\frac{d^2x_1}{dt^2} = \left[-\omega^2 X_1 \cos(\omega t)\right] m$$

$$-m\omega^2 X_1 \cos(\omega t) + 2k_1 \cdot X_1 \cos(\omega t) - k X_2 \cos(\omega t) = 0$$

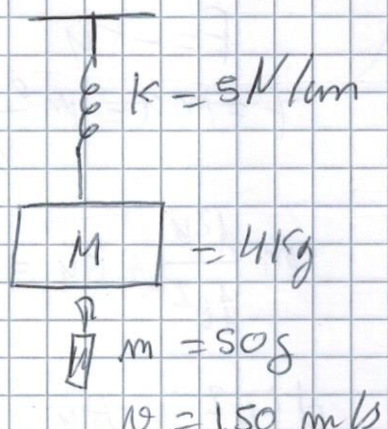
$$\begin{cases} [-m\omega^2 + 2k]\cdot X_1 - kX_2 = 0 \\ -kX_1 + [-m\omega^2 + k]X_2 = 0 \end{cases} \Longrightarrow \begin{bmatrix} [-m\omega^2 + 2k] & -k \\ -k & [-m\omega^2 + k] \end{bmatrix} = 0$$

$$\Rightarrow [-m\omega^2+2k][-m\omega^2+k]-k^2=0$$

$$\omega = \sqrt{\frac{3\pm\sqrt{5}}{2m}k} \quad (\text{rad/s})$$

TP 29/10/18

1



a) Amplitude do M.H.S? → Movimento Harmónico simples

b) Fração da E_c original que é convertida em E_M do oscilador?

→ colisão perfeitamente inelástica $\Rightarrow \Delta E_c \neq 0$

$\Delta\vec{P}=\vec{0}$

movimento yy'

$\rightarrow \Delta p = 0$

a massa m fica incrustada na massa M e o sistema começa a oscilar

$P_i = P_f$

↓ antes do choque

↘ imediatamente após o choque

$m v_i = (m+M) v_f$

$v_f = v_{máx}$ do MHS