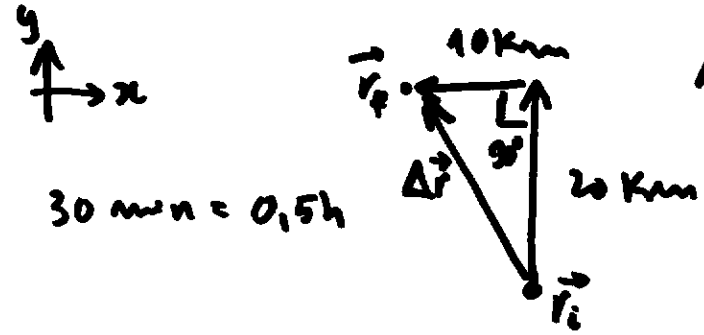
21048 Física Geral 2016-17 / Exame 2

Parte 2

① 

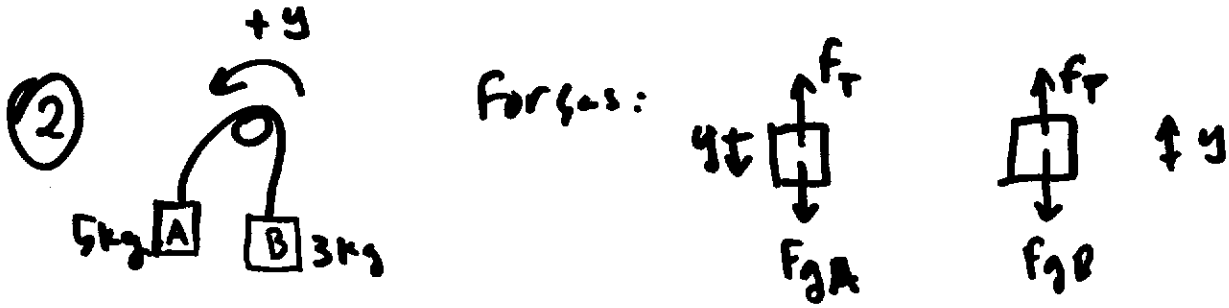
$\Delta r = |\Delta\vec{r}| = \sqrt{(10\,\text{Km})^2 + (20\,\text{Km})^2} = 22,36\,\text{Km}$

Velocidade média:

$$\vec{v}_m = \frac{\Delta\vec{r}}{\Delta t} \Leftrightarrow v_m = \frac{\Delta r}{\Delta t} = \frac{22,36\,\text{Km}}{0,5\,\text{h}}$$

$$\Leftrightarrow v_m = 44,72\ \text{Km/h}\ (\underline{45\ \text{Km/h}})$$

(E)

② 

2ª lei Newton:

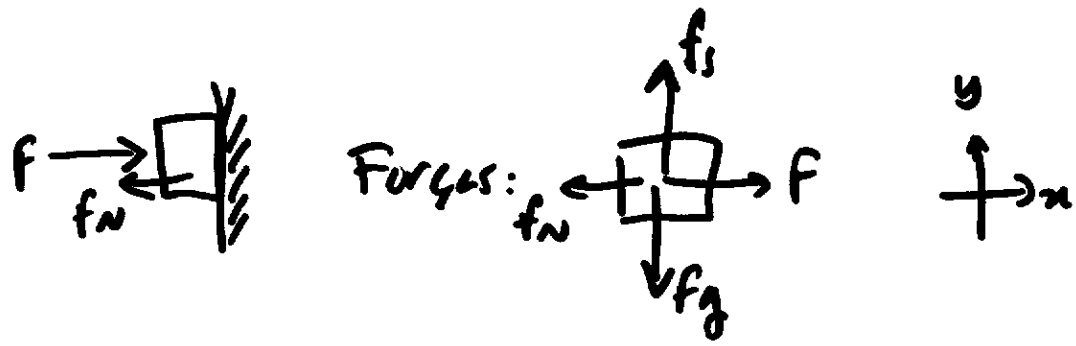
$$\begin{cases} A: -f_T + F_{gA} = m_A a \\ B: f_T - F_{gB} = m_B a \end{cases}$$

Somando as duas eqs. e substituindo valores:

$$-f_T + f_T + F_{gA} - F_{gB} = m_A a + m_B a$$

$$\Leftrightarrow (m_A - m_B) g = (m_A + m_B) a$$

$$\Leftrightarrow a = \frac{m_A - m_B}{m_A + m_B} g \Leftrightarrow a = \frac{5-3}{5+3} g = \frac{2}{8} g \Leftrightarrow \underline{a = g/4}\ (D)$$

③ 

Assumindo iminência de movimento, Temos

$f_r \leq \mu_s f_N \longrightarrow f_s = \mu_s f_N$.

(geral) (iminência de mov.)

Aplicando a 1ª Lei de Newton: ($\Sigma \vec{F} = 0$)

$$\begin{cases} x: -f_N + F = 0 \\ y: f_s - f_g = 0 \end{cases} \Leftrightarrow \begin{cases} F_N = 40N \\ \mu_s f_N = mg \end{cases}$$

$$\Leftrightarrow \begin{cases} \text{---} \\ \mu_s = \dfrac{(3{,}0\ kg)\cdot(9{,}8\ \frac{m}{s^2})}{40N} = 0{,}735 \quad (0{,}74) \end{cases}$$

(B)

④  De $\tau = I\alpha$ vem:

$\tau = 5{,}20\ N\cdot m$
$I = 1{,}80\ Kg\cdot m^2$

$$\alpha = \frac{\tau}{I} = \frac{5{,}20\ N\cdot m}{1{,}80\ Kg\cdot m^2} = 2{,}89\ \frac{rad}{s^2}$$

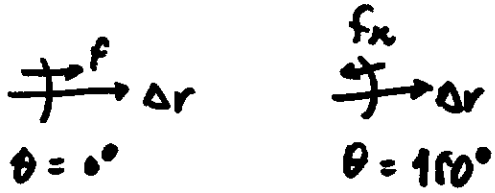
Das leis do MCUV: $\omega = \omega_0 + \alpha t$

$$\Leftrightarrow \omega = 0 + (2{,}89\ \tfrac{rad}{s^2})\cdot(0{,}40\ s)$$

$$\Leftrightarrow \omega = 1{,}156\ \tfrac{rad}{s} \quad (1{,}16\ \tfrac{rad}{s})$$

(A)

⑤



$W_F = F \Delta r \cos 0° = 16 \cdot 4 \cdot 1 = 64\ J$

$W_{f_k} = f_k \Delta r \cos 180° = 10 \cdot 4 \cdot (-1) = -40\ J$

$W_{tot} = W_F + W_{f_k} = 64\ J - 40\ J = 24\ J$

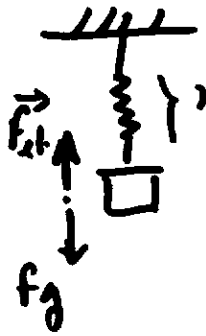
Teorema Trabalho – Energia: $W_{tot} = \Delta E_c$

$$24\ J = \frac{1}{2} m v_f^2 - \underbrace{\frac{1}{2} m v_i^2}_{=0}$$

$$24\ J = \frac{1}{2}(2{,}0\ kg)\, v_f^2$$

$$v_f = \sqrt{24}\ m/s = \underline{\underline{4{,}9\ m/s}} \quad (F)$$

⑥



1ª lei de Newton: $\Sigma \vec{F} = 0$

$f_{elast} - f_g = 0 \Leftrightarrow kx = mg$

$$\Leftrightarrow x = \frac{(2{,}0\ kg) \cdot (9{,}8\ m/s^2)}{45\ N/m}$$

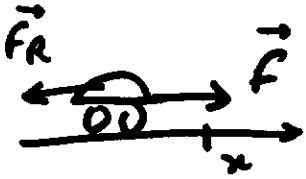
$\Leftrightarrow x = 0{,}4356\ m\ (\underline{44\ cm})$ (D)

(7) Numa colisão atuam apenas forças internas. Por isso $\vec{p}$ conserva-se sempre.

Já a energia cinética pode, ou não, conservar-se; se se conservar, a colisão é dita <u>elástica</u>. (D)

(8) A 2ª lei de Newton diz-nos que $\Sigma \vec{F} = m\vec{a}$.

Designando $+x$ como sentido do movimento:



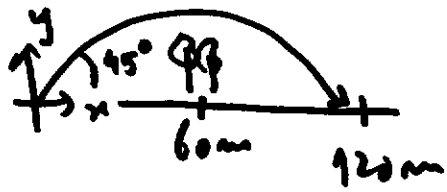
cf $f_R \sim bv^2$

Segundo x: $\Sigma \vec{F} = m\vec{a} \Rightarrow \Sigma F = m\frac{dv}{dt}$ ou:

$$m\frac{dv}{dt} = F - F_R$$

$$m\frac{dv}{dt} = K(1 - e^{-at}) - bv^2 \quad (A)$$

PARTE II

① 

(a) Da fórmula para alcance de um projétil temos:

$$R = \frac{V_0^2}{g}\operatorname{sen}(2\theta) \Leftrightarrow 120\,m = \frac{V_0^2}{9{,}8\,\frac{m}{s^2}}\operatorname{sen}(2\times 45°)$$

$$\Leftrightarrow V_0^2 = 120 \cdot 9{,}8 \cdot \underbrace{\operatorname{sen} 90°}_{=1} \quad (SI)$$

$$\Leftrightarrow V_0 = \sqrt{120 \cdot 9{,}8} = \underline{\underline{34{,}3\ m/s}}$$

(b) o tempo pode ser calculado de $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$.

o voo acaba em $y=0$: $0 = 0 + v_{0y}t - \frac{1}{2}gt^2$

$$\Leftrightarrow t = 0 \quad \text{ou} \quad v_{0y}t = \frac{1}{2}gt^2$$

$$2v_{0y} = gt$$

$$t = \frac{2V_{0y}}{g}$$

Como $V_{0y} = V_0 \cos 45° = V_0\frac{\sqrt{2}}{2}$ vem

$$t = \frac{2 \cdot V_0\frac{\sqrt{2}}{2}}{9{,}8} = 4{,}95\ s \quad \underline{\underline{(5{,}0\ s)}}$$

(c) A forma mais simples de resolver é notar que, por simetria, a Bola passa nos 60 m quando está a meio do seu voo, ou seja, quando $t = \frac{4,95}{2}$ s

i.e. $t_{\frac{1}{2}} = 2,475$ s

Nesta altura a bola está a y

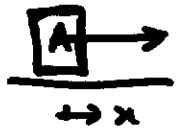
$$y = y_0 + \underbrace{v_{0y}}_{= v_0 \operatorname{sen} 45^\circ = v_0 \sqrt{2}/2} \cdot t_{\frac{1}{2}} - \frac{1}{2} g (t_{\frac{1}{2}})^2$$

$$y = 0 + \left(34,3 \tfrac{m}{s}\right) \cdot \frac{\sqrt{2}}{2} \cdot (2,475) - \frac{1}{2}\left(9,8 \tfrac{m}{s^2}\right) \cdot (2,475)^2$$

$$y = 60,02 \text{ m} - \left(4,9 \tfrac{m}{s^2}\right) \cdot (6,126 \text{ s}^2)$$

$$y = 30,00 \text{ m} \quad (\underline{\underline{30 \text{ m}}})$$

SIM, a bola consegue passar pelas árvores.

② (a)  (3,50 N ; 3,00 s)

Usando o Teorema de impulso–momento,

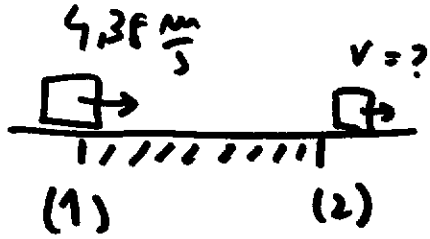
$$I = \Delta p \iff I = m\,\Delta v$$

$$F\Delta t = m v_f - \underbrace{m v_i}_{=0}$$

$$(3{,}50\ N)(3{,}00\ s) = (2{,}4\ kg)\cdot v_f - 0$$

$$v_f = \frac{3{,}50 \cdot 3{,}00}{2{,}40}\ \frac{m}{s} = 4{,}375\ \frac{m}{s}$$

$$(4{,}38\ \tfrac{m}{s})$$

(b) 

No Enunciado: $E_{c2} = \frac{1}{2} E_{c1}$

$$\frac{1}{2} m v_2^2 = \frac{1}{2}\left(\frac{1}{2} m v_1^2\right)$$

$$v_2^2 = \frac{1}{2} v_1^2$$

$$v_2 = \sqrt{v_1^2/2}$$

$$v_2 = 3{,}09\ \frac{m}{s}$$

(c)

Na colisão $\vec{p}_{total}$ conserva-se:

$$m_A v_{Ai} + \underbrace{m_B v_{Bi}}_{0} = \underbrace{m_A v_{Af}}_{0} + m_B v_{Bf}$$

$$(2{,}40\,kg)\cdot(3{,}09\,\tfrac{m}{s}) = (3{,}60\,kg)\,v_{Bf}$$

$$v_{Bf} = \frac{2{,}40 \cdot 3{,}09}{3{,}60} = \underline{\underline{2{,}06\,\tfrac{m}{s}}}$$

(d)

Sendo a compressão conservativa, vem

$$\Delta E_M = 0 \Rightarrow E_{C3} + E_{pelast\,3} = E_{C4} + E_{pelast\,4}$$

$$\frac{1}{2} m_B v_3^2 + 0 = 0 + \frac{1}{2} k x^2 \qquad (v_3 : 2{,}06\,\tfrac{m}{s})$$

$$k = \frac{m_B v_3^2}{x^2} = \frac{3{,}60\,kg \cdot (2{,}06\,\tfrac{m}{s})^2}{(0{,}185\,m)^2}$$

$$k = 446{,}4\ N/m \quad (\underline{\underline{446\ N/m}})$$

(3) Eq. diferencial pl velocidade:

$$m\frac{dv}{dt} = f(t,v)$$

$$\frac{dv}{dt} = \frac{1}{m}(3,00t - 2,00v^2) \qquad (SI)$$

$$\frac{dv}{dt} = \frac{3}{4}t - \frac{1}{2}v^2 \qquad (SI)$$

Integrando pelo RK2/Euler c/ $h = 0,5$ e $v_0 = 1,2$:

t (s)	v (m/s)	k_1	k_2
0	1,2	−0,72	0,1022
0,5	1,0256	−0,1508	0,2946
1,0	1,0625	0,1856	0,4577
1,5	1,2233	0,3768	0,5036
2,0	1,4434	———	———