FÍSICA GERAL E EXPERIMENTAL I

RESOLUÇÃO DA LISTA IV

UNIVERSIDADE CATÓLICA DE GOIÁS

Departamento de Matemática e Física

Disciplina: Física Geral e Experimental I (MAF 2201)

RESOLUÇÃO DA LISTA IV

1.

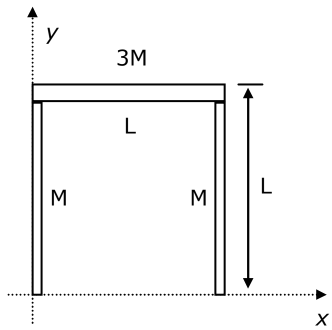
a) $x_{cm} = \dfrac{x_1 m_1 + x_2 m_2 + x_3 m_3}{m_1 + m_2 + m_3} = \dfrac{0.3 + 1.8 + 2.4}{3 + 8 + 4} \Rightarrow x_{cm} = 1{,}1m$

b) $y_{cm} = \dfrac{y_1 m_1 + y_2 m_2 + y_3 m_3}{m_1 + m_2 + m_3} = \dfrac{0.3 + 2.8 + 1.4}{3 + 8 + 4} = 1{,}3m$

c) ele se desloca em direção a essa partícula

2.

Podemos considerar as hastes como partícula colocadas no centro de massa de cada uma delas

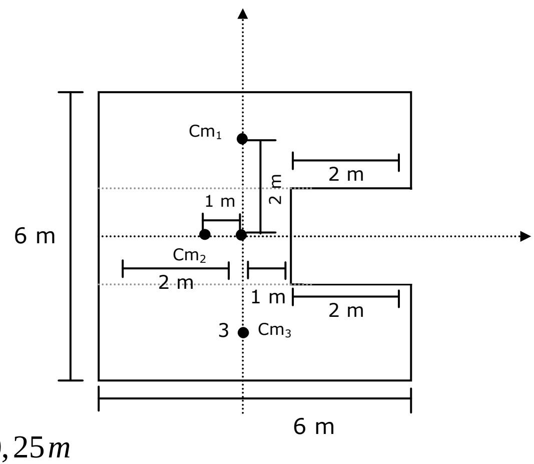


a) $x_{cm} = \dfrac{x_1 m_1 + x_2 m_2 + x_3 m_3}{m_1 + m_2 + m_3} \Rightarrow \dfrac{0.M + \frac{L}{2}.3M + L.M}{M + 3M + M} = \dfrac{L}{2}$

b) $y_{cm} = \dfrac{y_1 m_1 + y_2 m_2 + y_3 m_3}{m_1 + m_2 + m_3} \Rightarrow \dfrac{\frac{L}{2}.M + L.3M + \frac{L}{2}M}{5M} = \dfrac{4LM}{5M} = 0{,}8L$

3.

Dividindo a placa em 3 partes, podemos considerar cada parte como partícula colocada em seu centro de massa



$$x_{cm} = \frac{x_1 m_1 + x_2 m_2 + x_3 m_3}{m_1 + m_2 + m_3} \Rightarrow \frac{0.m_1 + 1.m_2 + 0.m_3}{m_1 + m_2 + m_3}$$

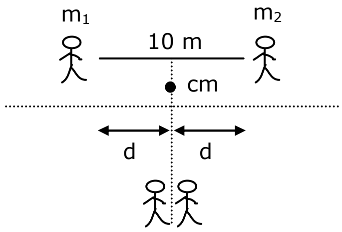
temos que: $m_1 = m_3 = m$ e $m_2 = \dfrac{2m}{3}$

$$\Rightarrow x_{cm} = \frac{-1.\frac{2m}{3}}{m + \frac{2m}{3} + m} = \frac{\frac{-2m}{3}}{\frac{8m}{3}} = \frac{-2m}{3}.\frac{3}{8m} = \frac{-2}{8} = -0{,}25m$$

$$y_{cm}=\frac{y_1m_1+y_2m_2+y_3m_3}{m_1+m_2+m_3}\Rightarrow\frac{2.m_1+0.m_2+-2.m_3}{m_1+m_2+m_3}=\frac{2m-2m}{m+\frac{2m}{3}+m}$$

$$\Rightarrow y_{cm}=0$$

4.



$m_1=65kg,\ \ m_2=40kg$

$\sum F_{ex}=0\Rightarrow c_m\Rightarrow$ está em repouso

$x'_{cm}=x_{cm}$

$$\Rightarrow\frac{x_1m_1+x_2m_2}{m_1+m_2}=\frac{d(m_1+m_2)}{m_1+m_2}\Rightarrow d=\frac{0.65+10.60}{65+40}=3{,}81m$$

$d'=10-3{,}81\Rightarrow d'=6{,}19m$

5.

$m_c=2400kg,\ \ v_c=80km/h,\ \ m_F=1600kg,\ \ v_F=60km/h,\ v_{cm}=?$

$M.\vec{V}_{cm}=m_c.\vec{v}_c+m_f.\vec{v}_f$, como as velocidades estão na mesma direção, temos que:

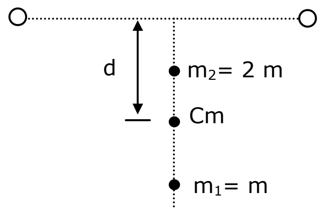
$\Rightarrow(2400+1600).v_{cm}=2400.80+1600.60\Rightarrow v_{cm}=72km/h$

6.

$v_{01}=v_{02}=0,\ y_{01}=y_{02}=0,\ t_1=300ms=0{,}3s\ \ \ e\ \ t_2=200ms=0{,}2s$

as pedras estão em queda livre

a)



$$y=y_0+v_0t-\frac{1}{2}gt^2\Rightarrow y=-\frac{9{,}8}{2}t^2=-4{,}9.t^2$$

$\Rightarrow y_1=-4{,}9.(0{,}3)^2=-0{,}441m$

$y_2=-4{,}9.(0{,}2)^2=-0{,}196m$

$$y_{cm}=\frac{y_1.m_1+y_2.m_2}{m_1+m_2}=\frac{-0{,}441.m-0{,}196.2m}{m+2m}=-0{,}28m$$

$\Rightarrow d=28cm$

b)

$M.\vec{v}_{cm}=m_1.\vec{v}_1+m_2.\vec{v}_2$ como o movimento é na vertical

$\Rightarrow M.V_{cm}=m_1.v_1+m_2.v_2$

$v=v_0-gt\Rightarrow v=-gt\Rightarrow v_1=-9{,}8.0{,}3=-2{,}94m/s\ \ e\ v_2=-9{,}8.0{,}2=-1{,}96m/s$

$\Rightarrow(m+2m)v_{cm}=-2.94m-1{,}96.2m\Rightarrow v_{cm}=-2{,}29m/s$

7.

$$\sum F_{ext} = 0 \Rightarrow c_m \rightarrow \text{ Permanece em repouso}$$

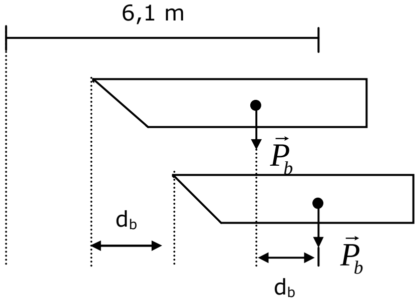
$$\Rightarrow x_{cm} = x_{cm}^{'}$$

$$\Rightarrow \frac{x_r m_r + x_c m_c + x_b m_b}{m_r + m_c + m_b} = \frac{x_r^{'}.m_r + x_c^{'} m_c + x_b^{'}.m_b}{m_r + m_c + m_b}$$

$$\Rightarrow 0,4.80 + 3,4 m_c + 1,9.30 = 3.80 + 0.m_c + 1,5.30$$

$$\Rightarrow m_c = 57,65 kg$$

8.



$$m_c = 4,5 kg,\ m_b = 18 kg$$

$$\sum \vec{F}_{ext} = 0 \Rightarrow x_{cm} \rightarrow \text{ permanece em repouso}$$

$$\Rightarrow x_{cm} = x_{cm}^{'}$$

$$\Rightarrow \frac{m_c.6,1 + m_b.d}{m_c + m_b} = \frac{m_c(6,1 - 2,4 + d_b) + m_b(d + d_b)}{m_c + m_b}$$

$$\Rightarrow m_c.6,1 + m_b.d = m_c.6,1 - m_c.2,4 + m_c.d_b + m_b.d + m_b.d_b$$

$$\Rightarrow 0 = -m_c.2,4 + (m_c + m_b).d_b \Rightarrow 0 = -4,5.2,4 + (4,5 + 18).d_b \Rightarrow d_b = 0,48 m$$

$$x_c^{'} = 6,1 - 2,4 + 0,48 \Rightarrow x_c^{'} = 4,18 m$$

9.

$$m_f = 816 kg,\ m_c = 2650 kg,\ v_c = 16 km/h$$

a) $P_f = P_c \Rightarrow m_f.v_f = m_c.v_c \Rightarrow 816.v_f = 2650.16 \Rightarrow v_f = 51,96 km/h$

b) $E_{kf} = E_{kc} \Rightarrow \frac{1}{2} m_f.v_f^2 = \frac{1}{2} m_c.v_c^2 \Rightarrow 816.v_f^2 = 2650.16^2 \Rightarrow v_f = 28,83 km/h$

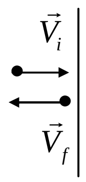
10.

$$m = 80 kg,\ m_c = 1600 kg,\ v_c = 1,2 km/h$$

$$P = P_c \Rightarrow m.v = m_c.v_c \Rightarrow 80.v = 1600.1,2 \Rightarrow v = 24 km/h$$

11.

Considerando:



$$m = 0,70 kg,\ \vec{v} = 5 m/s\,\hat{i},\ \vec{v}_f = -2 m/s\ \hat{i}$$

$$\Delta\vec{P} = \vec{P}_f - \vec{P}_i - 0,7.2\hat{i} - 0,7.5\hat{i} = -(4,9 kg\, m/s)\hat{i}$$

$$\Rightarrow \Delta P = 4,9 kg.m/s$$

12.

$$\vec{r} = (3500 - 160t)\hat{i} + 2700\hat{j} + 300\hat{k},\ m = 250\,kg$$

a)

$$\vec{P} = m\vec{v}$$

$$\vec{v} = \frac{d\vec{r}}{dt} = -(160\,m/s)\hat{i} \rightarrow \vec{P} = 250.(-160\hat{i}) \Rightarrow \vec{P} = -4.10^4\,kg.m/s$$

b) na direção $-x \rightarrow$ oeste

c)

$$\vec{F}_R = m.\vec{a}$$

$$\vec{a} = \frac{d\vec{v}}{dt} = 0 \Rightarrow \vec{F}_R = 0$$

13.

$$m_h = 91kg,\ m_p = 68g = 68.10^{-3}\,kg,\quad v_{FP} = 4m/s,\ V_{ih} = V_{iP} = 0$$

com o movimento é um uma dimensão,

$$\sum \vec{P}_i = \sum \vec{P}_F \Rightarrow m_h.v_{Fh} + m_p.v_{Fp} = 0 \Rightarrow 91.V_{hF} + 68.10^{-3}.4 = 0$$

$\Rightarrow V_{Fh} = -3.10^{-3}\,m/s$ (sentido contrário ao da pedra)

14.

$$m_1 = 1kg\ \ e\ \ m_2 = 3kg,\quad V_1 = 1{,}7\,m/s$$

$$v_{i1} = v_{i2} = 0$$

$$\sum \vec{P}_i = \sum \vec{P}_F \Rightarrow m_1 v_1 + m_2 v_2 = 0 \Rightarrow 1.1{,}7 + 3.v_2 = 0 \Rightarrow v_2 = -0{,}57\,m/s$$

15.

$$\vec{v}_i = (-0{,}4\,m/s)\hat{i},\quad m_A = 0{,}5kg,\ \vec{v}_{FA} = ?,\ \ m_B = 0{,}6\,kg,\ \vec{v}_{FB} = (0{,}2\,m/s)\hat{i}$$

$$m_c = 0{,}2\,kg,\quad \vec{v}_{FC} = (0{,}3\,m/s)\hat{i},\ m = m_A + m_B + m_C = 1{,}3\,kg$$

$$\sum \vec{P}_i = \sum \vec{P}_F \Rightarrow m.\vec{v}_i = m_A.\vec{v}_{FA} + m_B\vec{v}_{FB} + m_c.\vec{v}_{FC}$$

$$\Rightarrow 1{,}3.(0{,}4\hat{i}) = 0{,}5.\vec{v}_{FA} + 0{,}6.0{,}2\hat{i} + 0{,}2.0{,}3\hat{i} \Rightarrow \vec{v}_{FA} = -(1{,}4\,m/s)\hat{i}$$

16.

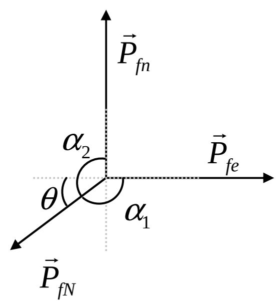
a) Supondo:

$\vec{P}_{FC} = (1,2.10^{-22}\, kg.m/s)\hat{i}$ e $\vec{P}_{FN} = (6,4.10^{-23}\ kg.m/s)\hat{j}$, $\vec{P}_{FN} = ?$

$$\sum \vec{P}_i = \sum \vec{P}_F \Rightarrow \vec{P}_{FN} + \vec{P}_{Fn} + \vec{P}_{Fe} = 0 \Rightarrow \vec{P}_{iN} + (1,2.10^{-22}\, kg\, m/s)\hat{i} + (6,4.10^{-23} kg.m/s)\hat{j} = 0$$

$$\Rightarrow \vec{P}_{FN} = -(1,2.10^{-22}\, kg.m/s)\hat{i} - (6,4.10^{-23}\, kg.m/s)\hat{j}$$

$$\Rightarrow P_{fN} = \sqrt{(1,2.10^{-22})^2 + (6,4.10^{-23})^2} = 1,36.10^{-22}\, kg.m/s$$



b)

$$tg\theta = \frac{6,4.10^{-33}}{1,2.10^{-22}} \Rightarrow \theta = 28^o$$

$$\alpha_1 = 180^o - \theta = 180^o - 28 = 152^o$$

c) $\alpha_2 = 90^o + \theta = 90^o + 28^o = 118^\circ$

d)

$$m = 5,8.10^{-26}\, kg \quad P_{FN} = m_N.v_{FN} \Rightarrow 1,36.10^{-22} = 5,8.10^{-26} v_{FN} \Rightarrow v_{FN} = 2345\, m/s$$

$$E_k = \frac{1}{2} m_N v_N^2 = \frac{1}{2}.5,8.10^{-26}(2345)^2 \Rightarrow E_k = 1,6.10^{-19}\, J$$

17.

$$m = 20\, kg, \quad \vec{v}_i = (200\, m/s)\hat{i},\ m_1 = 10kg,\ \vec{v}_{f1} = (100\, m/s)\hat{j}$$

$$m_2 = 4kg,\ \vec{v}_2 = -(500\, m/s)\hat{i}$$

a)

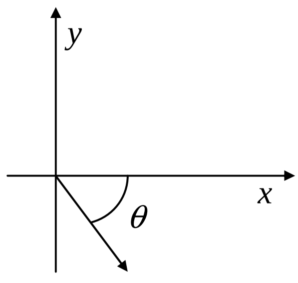
$$m_3 = 6\, kg \quad \vec{v}_{F3} = ?$$

$$\sum \vec{F}_{ext} = 0 \quad \Rightarrow \sum \vec{P}_i = \sum \vec{P}_F \Rightarrow M\vec{v}_i = m_1\vec{v}_{F1} + m_2\vec{v}_{F2} + m_3\vec{v}_{F3}$$

$$\Rightarrow 20.200\hat{i} = 10.100\hat{j} - 4.500\hat{i} + 6.\vec{v}_{F3} \Rightarrow \vec{v}_{F3} = \frac{(20.200 + 4.500)\hat{i} - 1000\hat{j}}{6} = 1000\hat{i} - 166,67\hat{j}$$

$$v_{F3} = 1013,79\, m/s$$

$$tg\theta = \frac{166,67}{1000} \Rightarrow \theta = 9,46^o$$



b)

$$E_{ki} = \frac{1}{2} M v_i^2 = \frac{1}{2} 20.200^2 = 4.10^5\, J$$

$$E_{kf} = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 + \frac{1}{2} m_3 v_3^2 = \frac{1}{2}(10.100^2 + 4.500^2 + 6.1013,79^2)$$

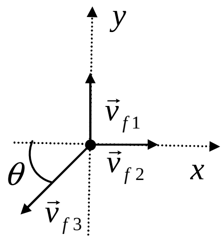
$$\Rightarrow E_{kf} = 3,63.10^6\, J$$

$$\Delta E_k = E_{kf} - E_{ki} = 3,63.10^6 - 4.10^5 = 3,23.10^6\ J$$

18.

$v_i = 0$

$m_1 = m_2 = m,\ m_3 = 3m,$ supondo:



$\vec{v}_{f1} = (30m/s)\hat{i},\ \ \vec{v}_{f2} = (30m/s)\hat{j}$

$\sum \vec{F}_{ext} = 0 \Rightarrow \sum \vec{P}_i = \sum \vec{P}_f \Rightarrow m_1\vec{v}_{f1} + m_2\vec{v}_{f2} + m_3\vec{v}_{f3} = 0$

$\Rightarrow m.30\hat{i} + m.30\hat{j} + 3m\ \ \vec{v}_{f3} = 0 \Rightarrow \vec{v}_{f3} = (-10\hat{i} + 10\hat{j})m/s$

$v_{f3} = \sqrt{10^2 + 10^2} = 14{,}14m/s \qquad tg\theta = \dfrac{10}{10} \Rightarrow \theta = 45^{\circ}$

19.

$M_i = 6090kg,\ v_i = 105m/s,\ M_f = 6090 - 80 = 6010kg$

$v_{rel} = 253m/s$

$v_f - v_i = v_{rel}\ \ln\left(\dfrac{M_i}{M_f}\right) \Rightarrow v_f = 105 + 253\ \ln\left(\dfrac{6090}{6010}\right) \rightarrow v_f = 108{,}34m/s$

20.

$v_i = 6.10^3\,m/s,\ v_{rel} = 3.10^3\,m/s,\ M = 4.10^4\,kg,\ a = 2m/s^2$

a) $E = M.a = 4.10^4.2 = 8.10^4\,N$

b) $R = ?\ \ v_{rel}.R = M.a \Rightarrow 3.10^3 R = 4.10^4.2 \Rightarrow R = 26{,}67kg/s$

21.

$M_i = 2{,}55.10^5\,kg, \qquad M_c = 1{,}81.10^5\ kg,\ \ \Delta t = 250s,\ \ v_i = 0$

$\dfrac{dm}{dt} = 480\ kg/s,\ \ v_{rel} = 3{,}27km/s$

a) $E = v_{rel}.R = V_{rel}.\dfrac{dm}{dt} = 3{,}27.10^3.480 = 1{,}57.10^6\,N$

b) $m_c^{'} = 480.250 = 1{,}2.10^5\,kg$ (combustível consumido)

$\Rightarrow M_f = 2{,}55.10^5 - 1{,}2.10^5 = 1{,}35.10^5\,kg$

c) $v_f - v_i = v_{rel}\ \ln\left(\dfrac{M_i}{M_f}\right) \Rightarrow v_f = 3{,}27\ \ln\left(\dfrac{2{,}55.10^5}{1{,}35.10^5}\right) = 2{,}08\ km/s$

22.

$F_m = 50N \qquad m = 0{,}2kg \rightarrow$ movimento em uma dimensão.

$\Delta t = 10\,ms = 10^{-2}\,s$

$j = \Delta P \rightarrow F_m.\Delta t = m.v_f - mv_i$

$\rightarrow 50.10^{-2} = 0,2.v_f \rightarrow v_f = 2,5\,m/s$

23.

$m = 150g = 0\ ,15kg,\ \ v_i = 40m/s,\ v_f = -60\,m/s,\ \Delta t = 5.10^{-3}s,$

como o movimento é em uma dimensão

$j = \Delta p \Rightarrow F_m.\Delta t = mv_f - mv_i \rightarrow F_m.5.10^{-3} = 0,15(-60-40) \rightarrow F_m = -3000M$

$\rightarrow |F_m| = 3000N$

25.

Movimento em uma dimensão

$m = 1,2\,kg,\ \ v_i = -25\,m/s,\ v_f = 10\,m/s,\ \Delta t = 0,02s$

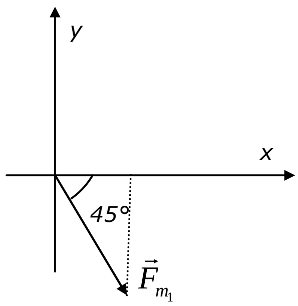
a) $j = \Delta p = mv_f - mv_i = 1,2.10 - 1,2.(-25) = 42\,N.s$

b) $j = F_m.\Delta t \Rightarrow 42 = F_m.0,02 \Rightarrow F_m = 2100\,N$

26.

$m = 1400\,kg,\ \vec{v}_i = 5,3\,m/s\,\hat{j},\ \Delta t_1 = 4,6s,\ \Delta t_2 = 35\,ms = 0,35s$

a)



$\vec{v}_2 = 5,3\,m/s\,\hat{i}$

$\vec{j}_1 = \Delta\vec{p} = \vec{P}_f - \vec{P}_i = m\vec{v}_f - m\vec{v}_i = 1400.(5,3\hat{i} - 5,3\hat{j})$

$\Rightarrow \hat{j}_1 = (7420\hat{i} - 7420\hat{j})N.s$

b) $\vec{j}_2 = \Delta\vec{p} = \vec{p}_f - \vec{P}_i = -m\vec{v}_2 = -1400.5,3\hat{i} \Rightarrow \vec{j}_2 = -(7420\hat{i})N.s$

c) $j_1 = F_{m_1}.\Delta t_1 = \sqrt{7420^2 + 7420^2} = F_{m_1}.4,6 \Rightarrow F_{m_1} = 2,28.10^3\,N$

d) $j_2 = F_{m_2}.\Delta t_2 \Rightarrow 7420 = F_{m_2}.0,35 \Rightarrow F_{m_2} = 2,12.10^4\,N$

e) A direção de $\vec{F}_{m_1}$ é a mesma de $\vec{j}_1$

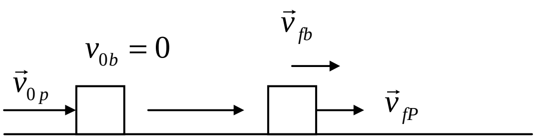
27.

Movimento em uma dimensão

$$m = 10kg,\ F_i = 0,\ F_f = 50N,\ \Delta t = 4s,\ v_i = 0$$
$$F = A.t,\ p/t = 4 \Rightarrow F = 50 \Rightarrow 50 = A.4 \Rightarrow A = 12,5N/s \Rightarrow F = 12,5t$$
$$j = \Delta p \Rightarrow \int_0^4 Fdt = mv_f - mv_i \Rightarrow \int_0^4 12,5t\ \ dt = mv_f$$
$$\Rightarrow 12,5\ \frac{t^2}{2}\Big|_0^4 = mv_f$$
$$\Rightarrow 12,5.\frac{4^2}{2} = 10.v_f \Rightarrow v_f = 10m/s$$

28.

O movimento é em uma dimensão



$$m_p = 5,2g = 5,2.10^{-3}kg,\ v_{ip} = 672m/s,\ m_b = 700g = 0,7kg$$
$$v_{ib} = 0,\ v_{Fp} = 428m/s$$

a) $v_{Fb} = ?$

$$\sum F_{ex} = 0 \Rightarrow \sum P_i = \sum P_f \Rightarrow m_p v_{0p} + m_b.v_{0b} = m_p.v_{Fp} + m_b v_{Fb}$$
$$\Rightarrow 5,2.10^{-3}.672 = 5,2.10^{-3}.428 + 0,7.v_{Fb} \Rightarrow v_{Fb} = 1,81\ \ m/s$$

b)

$$M.V_{cm} = m_p.v_{ip} + m_b v_{ib}$$
$$\Rightarrow (5,2.10^{-3} + 0,7)V_{cm} = 5,2.10^{-3}.672 \Rightarrow V_{cm} = 4,9\ m/s$$

29.

$$m_t = 6kg,\ v_{it} = 9m/s,\ m_p = 12kg,\ v_{ip} = 0$$
$$\sum F_{ex} = 0 \Rightarrow \sum \vec{P}_i = \sum \vec{P}_f \Rightarrow m_t.v_{it} + m_p.v_{ip} = (m_t + m_p)v_f$$
$$\Rightarrow 6.9 = (6+12).v_f \Rightarrow v_f = 3m/s$$

30.

O movimento é em uma dimensão

$$m_p = 4,5g = 4,5.10^{-3}kg,\ m_b = 2,4kg,\ v_{ib} = 0,\ \mu = 0,2,\ d = 1,8m$$

a)

$$\Delta E = w_{fat} \Rightarrow u_f + E_{kf} - (\mu_i + E_{ki}) = -\mu_c.n.d$$
$$\Rightarrow -\frac{1}{2}(m_p + m_b)v_i^2 = -\mu_c.(m_p + m_b).g.d \Rightarrow \frac{v_i^2}{2} = 0,2.9,8.1,8$$

$\Rightarrow v_i = 2,7\,m/s$

b)

$$\sum \vec{P}_i = \sum \vec{P}_f \Rightarrow m_p.v_{ip}^{'} + m_b.v_{ib}^{'} = (m_p + m_b)v_i$$
$$\Rightarrow 4,5.10^{-3}.v_{ip}^{'} = (4,5.10^{-3} + 2,4).2,7$$
$$\Rightarrow v_{ip}^{'} = 1442,7\,m/s$$

31.

$$m_A = 1100\,kg,\ m_g = 1400\,kg,\ \mu_k = 0,13,\ d_A = 8,2m,\ d_B = 6,1m$$

a)

$$v_{iA} = ?$$
$$\Delta E = w_{fat} \Rightarrow u_f + E_{kf} - (u_i + E_{ki}) = -\mu_c.mgd \Rightarrow \frac{1}{2}mv_i^2 = \mu_c.mgd$$
$$\Rightarrow v_i = \sqrt{2.\mu_c.gd} \Rightarrow v_{iA} = \sqrt{2.0,13.9,8.8,2} \Rightarrow v_{iA} = 4,6\,m/s$$

b) $v_{iB} = \sqrt{2.\mu_c.g.d_B} = \sqrt{2.0,13.9,8.6,1} \Rightarrow v_{iB} = 3,9\,m/s$

c)

imediatamente antes e após a colisão, temos que:

$$\sum \vec{P}_i = \sum \vec{P}_f \Rightarrow m_A.v_{iA}^{'} + m_B.v_{iB}^{'} = m_A v_{iA} + m_B v_{iB}$$
$$\Rightarrow 1400.v_{iB}^{'} = 1100.4,6 + 1400.3,9 \Rightarrow v_{iB}^{'} = 7,5\,m/s$$

32.

$$m_1 = 2\,kg,\ v_{1i} = 10\,m/s,\ m_2 = 5\,kg,\ v_{2i} = 3\,m/s,\ k = 1120\,N/m$$
$$\sum \vec{P}_i = \sum \vec{P}_f \Rightarrow m_1 v_{1i} + m_2.v_{2i} = (m_1 + m_2)v_f$$
$$\Rightarrow 2.10 + 5.3 = (2+5)v_f \Rightarrow v_f = 5\,m/s$$

a energia mecânica do sistema se conserva

$$E_i = E_f \Rightarrow E_{ki} + u_i = E_{kf} + u_f$$
$$\Rightarrow \frac{1}{2}m_1 v_{i1}^2 + \frac{1}{2}m_2 v_{i2}^2 = \frac{1}{2}(m_1 + m_2)v_f^2 + \frac{1}{2}kx^2$$
$$\Rightarrow 2.10^2 + 5,3^2 = (2+5).5^2 + 1120.x^2 \Rightarrow x = 0,25\,m$$

33.

$$m_1 = 340g = 0,34\,kg,\ v_{1i} = 1,2\,m/s,\ v_{2i} = 0,\ v_{1f} = 0,66\,m/s$$

a) e b)

$$\sum \vec{P}_i = \sum \vec{P}_f \Rightarrow m_1.v_{1i} + m_2 v_{2i} = m_2 v_{2f} + m_1 v_{1f}$$
$$\Rightarrow 0,34.1,2 = 0,34.0,66 + m_2.v_{2f}$$
$$\Rightarrow 0,184 = m_2 v_{2f}$$

na colisão elástica a energia cinética do sistema se conserva

$$E_{k_{1i}} + E_{k_{2i}} = E_{k_{1f}} + E_{k_{2f}} \Rightarrow \frac{1}{2}m_1 v_{1i}^2 = \frac{1}{2}m_1 v_{1f}^2 + \frac{1}{2}m_2 v_{2f}^2$$
$$\Rightarrow 0,34.(1,2)^2 = 0,34.(0,66)^2 + m_2 v_{2f}^2 \Rightarrow 0,341 = m_2 v_{2f}^2$$
$$\Rightarrow 0,341 = m_2.v_{2f}.v_{2f} \Rightarrow 0,341 = 0,184.v_{2f} \Rightarrow v_{2f} = 1,86\, m/s$$
$$\Rightarrow m_2 = \frac{0,184}{1,86} = 0,099\, kg$$

c) $v_{cm} = \dfrac{v_{1i}m_1 + v_{2i}m_2}{m_1 + m_2} = \dfrac{0,34.1,2}{0,34 + 0,099} = 0,93\, m/s$

34.

$$m_1 = 0,5\,kg,\ L = 70\,cm = 0,7m_1,\ m_2 = 2,5kg,\ v_{2i} = 0$$

Cálculo da velocidade da bola imediatamente antes da colisão. Considerando apenas a bola, temos que:

$$E_i = E_f \Rightarrow u_i + \frac{1}{2}mv_i^2 = u_F + \frac{1}{2}mv_F^2 \Rightarrow mgh = \frac{1}{2}mv_F^2$$
$$\Rightarrow v_F = \sqrt{2gL} = \sqrt{2.9,8.0,7} = 3,7\, m/s$$

Considerando a bola e o bloco, imediatamente antes e depois da colisão, temos que:

$$\sum \vec{P}_i = \sum \vec{P}_F \Rightarrow m_1 v_{1i}' + m_2 v_{2i}' = m_1 v_{1f}' + m_2 v_{2f}'$$
$$\Rightarrow 0,5.3,7 = 0,5.v_{1f}' + 2,5.v_{2f}' \Rightarrow 3,7 = v_{1f}' + 5v_{2f}' \Rightarrow v_{1f}' = 3,7 - 5v_{2f}'$$

Na colisão elástica a energia cinética se conserva

$$\Rightarrow \frac{1}{2}m_1 v_{1i}'^2 + \frac{1}{2}m_2 v_{2i}'^2 = \frac{1}{2}m_1 v_{1f}'^2 + \frac{1}{2}m_2 v_{2f}'^2$$
$$\Rightarrow 0,5.(3,7)^2 = 0,5.v_{1f}'^2 + 2,5v_{2f}'^2 \Rightarrow 13,69 = v_{1f}'^2 + 5v_{2f}'^2$$
$$\Rightarrow 13,69 = (3,7 - 5v_{2f}')^2 + 5v_{2f}'^2 \Rightarrow v_{2f}' = 1,23\, m/s\ \ e\ \ v_{1f}' = 3,7 - 5v_{2f}' = -2,45\, m/s$$

35.

$$m_A = m_B = 2\,kg,\ \vec{v}_{iA} = 15\hat{i} + 30\hat{j},\ \vec{v}_{iB} = -10\hat{i} + 5\hat{j}$$
$$\vec{v}_{FA} = -5\hat{i} + 20\hat{j}$$

a)

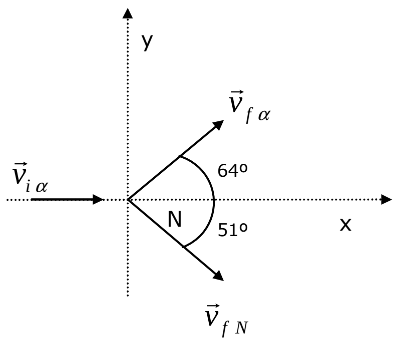
$$\sum \vec{P}_i = \sum \vec{P}_f \Rightarrow m_A\vec{v}_{iA} + m_B\vec{v}_{iB} = m_A\vec{v}_{fA} + m_B\vec{v}_{fB}$$
$$\Rightarrow 15\hat{i} + 30\hat{j} - 10\hat{i} + 5\hat{j} = -5\hat{i} + 20\hat{j}.\vec{v}_{fB}$$
$$\Rightarrow \vec{v}_{fB} = (10\hat{i} + 15\hat{j}) m/s$$

b)

$$E_{ki} = \frac{1}{2}m_A v_{Ai}^2 + \frac{1}{2}m_B v_{Bi}^2$$
$$v_{Ai} = \sqrt{15^2 + 30^2} = 33{,}54\, m/s,\ v_{Bi} = \sqrt{10^2 + 5^2} = 11{,}18\, m/s,\ v_{Af} = \sqrt{5^2 + 20^2} = 20{,}61\, m/s$$
$$v_{Bf} = \sqrt{10^2 + 15^2} = 18{,}03\, m/s$$
$$\Rightarrow E_{ki} = \frac{1}{2}.2(33{,}54)^2 + \frac{1}{2}.2.(11{,}18)^2 = 1249{,}92\, J$$
$$E_{kf} = \frac{1}{2}.2.(20{,}61)^2 + \frac{1}{2}.2.(18{,}03)^2 = 749{,}85 J$$
$$\Delta E_k = E_{kf} - E_{ki} = 749{,}85 - 1249{,}92 = -500{,}07 J$$

36.

$$m_\alpha = 4u,\ m_N = 16u,\ v_{iN} = 0,\ v_{fN} = 1{,}2.10^5\, m/s$$



a)

$$\sum \vec{P}_i = \sum \vec{P}_f \Rightarrow m_\alpha\vec{v}_{i\alpha} + m_N\vec{v}_{Ni} = m_\alpha\vec{v}_{F\alpha} + m_N\vec{v}_{FN}$$
$$\Rightarrow 4.v_{i\alpha}\hat{i} = 4(v_{F\alpha}\cos 64^o\,\hat{i} + v_{F\alpha}\,\text{sen}\,64^o\,\hat{j}) + 16(1{,}2.10^5\cos 51^o\,\hat{i} - 1{,}2.10^5\, sen 51^o\,\hat{j})$$
$$v_{i\alpha}\hat{i} = (v_{F\alpha}\cos 64^o + 3{,}02.10^5)\hat{i} + (V_{F\alpha}\,\text{sen}\,64^o - 3{,}73.10^5)\hat{j}$$
$$\Rightarrow V_{F\alpha}\,\text{sen}\,64^o - 3{,}73.10^5 = 0 \Rightarrow v_{F\alpha} = 4{,}15.10^5\, m/s$$

b)

$$v_{i\alpha} = v_{F\alpha}\cos 64^o + 3{,}02.10^5 = 4{,}15.10^5.\cos 64^o + 3{,}02.10^5 \Rightarrow v_{i\alpha} = 4{,}84.10^5\, m/s$$

37.

$$m_1 = m_2 = m, \quad v_{i2} = 0, \quad v_{1f} = 3{,}5\, m/s,\ v_{2f} = 2\, m/s$$

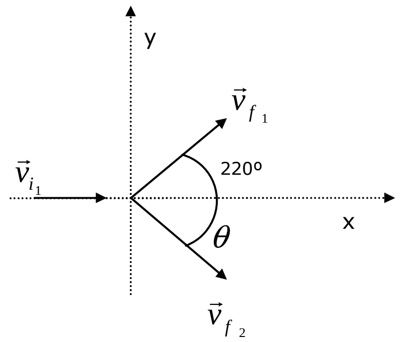
a)

$$\sum \vec{P}_i = \sum \vec{P}_f \Rightarrow m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$$

$$\Rightarrow v_{1i}\hat{i} = 3{,}5\cos 22^o\,\hat{i} + 3{,}5\,\text{sen}\,22^o\,\hat{j} + 2\cos\theta\,\hat{i} - 2\,\text{sen}\,\theta\,\hat{j}$$

$$\Rightarrow v_{1i}\hat{i} = (3{,}5\cos 22^o + 2\cos\theta)\hat{i} + (3{,}5\,\text{sen}\,22^o - 2\,\text{sen}\,\theta)\hat{j}$$

$$\Rightarrow 3{,}5\,\text{sen}\,22^o - 2\,\text{sen}\,\theta = 0 \Rightarrow \theta = 40{,}96^o$$



b) $v_{1i} = 3{,}5\cos^o 22 + 2\cos(40{,}96^o) \Rightarrow v_{1i} = 4{,}75\,m/s$

c)

$$E_{ki} = \frac{1}{2}m_1v_{1i}^2 + \frac{1}{2}m_2v_{2i}^2 = \frac{1}{2}.m(4{,}75)^2 = 11{,}28\,m$$

$$E_{kf} = \frac{1}{2}m_1v_{1f}^2 + \frac{1}{2}m_2v_{2f}^2 = \frac{1}{2}m(3{,}5)^2 + \frac{1}{2}m.2^2 = 8{,}125\,m$$

$E_{ki} \neq E_{kf} \Rightarrow$ não

38.

$$m_1 = m_2 = m,\;\; v_{1i} = v_{2i} = v_i,\;\; v_f = \frac{v_i}{2}$$

$$\sum \vec{P}_i = \sum \vec{P}_f$$

$$\Rightarrow m(v_i\cos\theta_1\,\hat{i} - v_i\text{sen}\,\theta_1\,\hat{j}) + m(v_i\cos\theta_2\hat{i} + v_i.\text{sen}\theta_2\,\hat{j}) = 2m\,v_f\,\hat{i}$$

$$\Rightarrow v_i(\cos\theta_1\,\hat{i} - \text{sen}\,\theta_i\,\hat{j}) + v_i(\cos\theta_2\,\hat{i} + \text{sen}\,\theta_2\,\hat{j}) = 2\frac{v_i}{2}\hat{i}$$

$$\Rightarrow (\cos\theta_1 + \cos\theta_2)\hat{i} + (-\text{sen}\,\theta_1 + \text{sen}\,\theta_2)\hat{j} = 1\hat{i}$$

$$\Rightarrow -sen\,\theta_1 + sen\theta_2 = 0 \Rightarrow \text{sen}\,\theta_1 = \text{sen}\,\theta_2 \Rightarrow \theta_1 = \theta_2$$

$$\cos\theta_1 + \cos\theta_2 = 1 \Rightarrow \cos\theta_1 + \cos\theta_1 = 1 \Rightarrow 2\cos\theta_1 = 1 = \theta_1 = 60^o$$

$$\Rightarrow \alpha = 2\theta_1 = 2.60 \Rightarrow \alpha = 120^o$$