

Correction de la série P₃

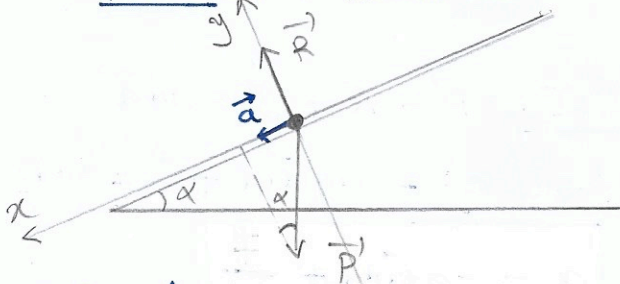
Exercice 2:

1.1. Système: skieur

Ref: TSG

BFA: $\vec{P}$ et $\vec{R}$

T.C.I: $\vec{P} + \vec{R} = m\vec{a}$



Suivant x: $R_x + P_x = ma_x$

$$\Rightarrow 0 + P \sin \alpha = ma$$

$$\Rightarrow \boxed{a = g \sin \alpha} \quad \text{AN: } \boxed{a = 5 \text{ m/s}^2}$$

Par définition: $a = \frac{dv}{dt} \Rightarrow v = at + c_1$

$$\text{A } t=0; v_0 = c_1 = 0$$

$$\Rightarrow \boxed{v = 5t}$$

Par définition: $v = \frac{dx}{dt} \Rightarrow$

$$x = \frac{5}{2} t^2 + c_2$$

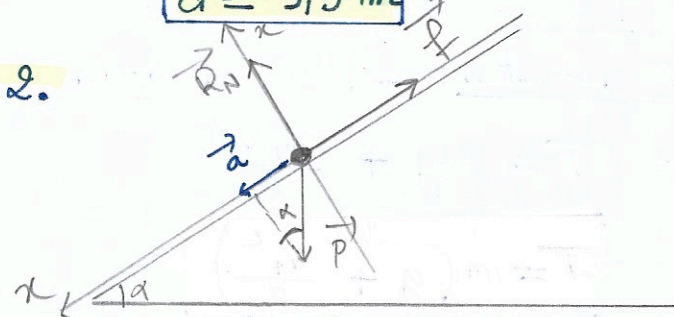
$$\text{A } t=0; x_0 = c_2 = 0 \Rightarrow$$

$$\boxed{x = 2,5 t^2}$$

$$1.2. 2ad = v_2^2 - v_1^2$$

$$\Rightarrow \boxed{d = \frac{v_2^2 - v_1^2}{2a}} = \frac{10^2 - 1^2}{2 \times 5}$$

$$\boxed{d = 9,9 \text{ m}}$$



T.C.I: $\vec{P} + \vec{f} + R_N = m\vec{a}$

Suivant x: $mg \sin \alpha - f + 0 = ma$

$$\Rightarrow \boxed{a = g \sin \alpha - \frac{f}{m}}$$

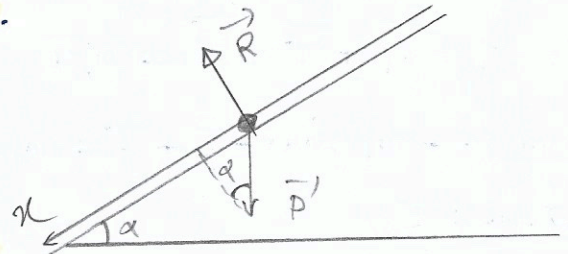
$$\text{AN: } \boxed{a = 4 \text{ m/s}^2}$$

$$v_x = 4t \quad \text{et} \quad x = 2t^2$$

$$\boxed{d = \frac{v_2^2 - v_1^2}{2a}} = 12,375 \text{ m}$$

Exercice 3:

1.1.



1.2.

Système: S₁

Ref: TSG

BFA: $\vec{P}$ et $\vec{R}$

T.C.I: $\vec{P} + \vec{R} = m\vec{a}$

Suivant x: $mg \sin \alpha + 0 = ma$

$$\Rightarrow \boxed{a = g \sin \alpha} \quad \text{AN: } \boxed{a = 5 \text{ m/s}^2}$$

C'est un MRUV.

$$1.3. v_B^2 - v_A^2 = 2ad \quad \text{or } v_A = 0$$

$$\Rightarrow \boxed{v_B = \sqrt{2ad}} = \sqrt{2 \times 5 \times 2,5}$$

$$\boxed{v_B = 5 \text{ m/s}}$$

$$1.4. a = \frac{dv}{dt} \Rightarrow v = 5t + c_1$$

$$\text{A } t=0; v_0 = c_1 = 0 \Rightarrow v = 5t$$

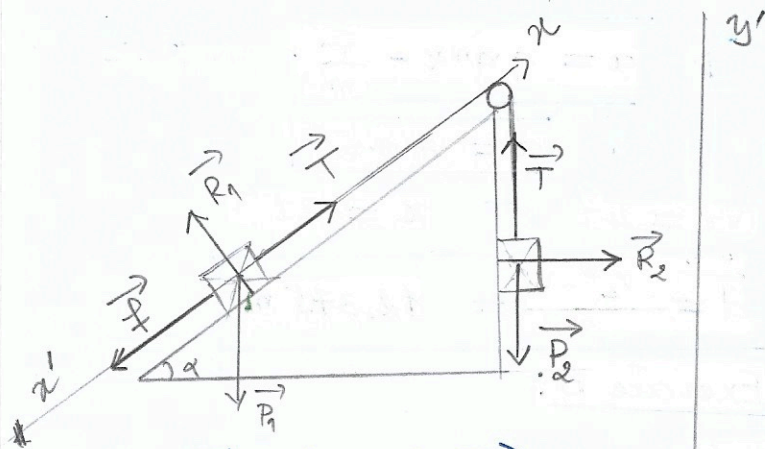
$$\text{Au point B: } v_B = at_B \Rightarrow \boxed{t_B = \frac{v_B}{a}}$$

$$t_B = \frac{5}{5} = 1 \text{ s} \Rightarrow \boxed{t_B = 1 \text{ s}}$$

2.1. Système: S₁

Ref: TSG

BFA: $\vec{P}_1, \vec{R}_1; \vec{f}_1$ et $\vec{T}_1$



TCI: $\vec{P}_1 + \vec{R}_1 + \vec{T} + \vec{f} = m_1 \vec{a}$

Suivant x: $-m_1 g \sin \alpha - f + T = m_1 a$ ①

Système: S_2

Ref: TSG

BFA: $\vec{P}_2$; $\vec{R}_2$ et $\vec{T}$

TCI: $\vec{P}_2 + \vec{R}_2 + \vec{T} = m_2 \vec{a}$

Suivant y: $P_2 - T = m_2 a$

$\Rightarrow T = m_2 g - m_2 a$ ②

② Dans ① :

$-m_1 g \sin \alpha - f + m_2 g - m_2 a = m_1 a$

Pourvu $m_1 = m_2 = m$

$\Rightarrow mg(1 - \sin \alpha) - f = 2ma$

$\Rightarrow a = \frac{g}{2}(1 - \sin \alpha) - \frac{f}{2m}$

2.2. AN: $a = 2 \text{ m} \cdot \text{s}^{-2}$

Le MRUV.

2.3. $a = \frac{dv}{dt} \Rightarrow v = at + c_1$

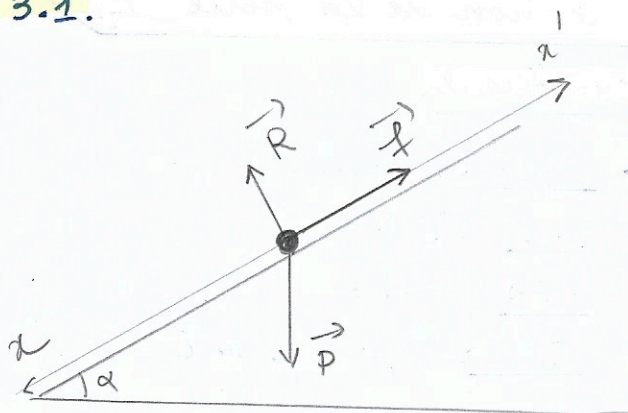
or à $t=0$; $v_0 = c_1 = 0$

$\Rightarrow v = 2t$

Au point c: $v_c = 2t_c \Rightarrow$

$v_c = 2 \text{ m} \cdot \text{s}^{-1}$

3.1.



T.C.I: $\vec{P} + \vec{R} + \vec{f} = m \vec{a}$

Suivant x: $-mg \sin \alpha + f = ma_1$

$\Rightarrow a_1 = -g \sin \alpha + \frac{f}{m}$

AN: $a_1 = -4 \text{ m/s}^2$

3.2. $v_B^2 - v_c^2 = 2ad$ or $v_B = 0$

$\Rightarrow d = \frac{-v_c^2}{2a} \Rightarrow d = 0,25 \text{ m}$

Exercice 4:

1. TEC: $\frac{1}{2} m v_1^2 - \frac{1}{2} m v_0^2 = mgh$
or $h = l(1 - \cos \alpha)$ et $v_0 = 0$

$\Rightarrow \frac{1}{2} m_1 v_1^2 = m_1 g l (1 - \cos \alpha)$

$\Rightarrow v_1 = \sqrt{2gl(1 - \cos \alpha)}$

AN: $v_1 = 8,82 \text{ m/s}$

2. La tension du fil:

TCI: $\vec{P} + \vec{T} = m \cdot \vec{a}$

Suivant n: $-P + T = m_2 a_n$

$\Rightarrow T = mg + \frac{m_1 v_1^2}{l}$

$T = m(g + \frac{v_1^2}{l})$

AN: $T = 3,85 \text{ N}$

②

3. Vitesse de la boule B₂ après

le choc :

$$\vec{p}_{\text{avant}} = m_1 \cdot \vec{v}_1$$

$$\vec{p}_{\text{après}} = m_1 \cdot \vec{v}_1' + m_2 \cdot \vec{v}_2'$$

Conservation de $\vec{p}$

$$m_1 \cdot \vec{v}_1 = m_1 \cdot \vec{v}_1' + m_2 \cdot \vec{v}_2'$$

Dans le sens du mouvement :

$$m_1 v_1 = m_1 v_1' + m_2 v_2'$$

$$\text{or } m_1 = 2m_2$$

$$\Rightarrow v_2 = 2(v_1 - v_1') \quad (1)$$

Conservation de E_c :

$$\frac{1}{2} m_1 v_1^2 = \frac{1}{2} m_1 v_1'^2 + \frac{1}{2} m_2 v_2'^2$$

$$\text{or } m_1 = 2m_2$$

$$\Rightarrow v_2^2 = 2(v_1^2 - v_1'^2) \quad (2)$$

$$\frac{(2)}{(1)} \Rightarrow \frac{v_2^2}{v_2} = \frac{2(v_1 - v_1')(v_1 + v_1')}{2(v_1 - v_1')}$$

$$\Rightarrow v_2 = v_1 + v_1' \Rightarrow v_1' = v_2 - v_1 \quad (3)$$

$$(5) \text{ dans } (1) \Rightarrow v_2 = 2(v_1 - v_2 + v_1)$$

$$\Rightarrow 3v_2 = 4v_1 \Rightarrow v_2 = \frac{4}{3} v_1$$

$$\text{AN : } v_2 = 11,76 \text{ m/s}$$

4. Equations horaires :

Système : B₂

Ref : TSG

$$\text{BFA : } \vec{p}_2 = m_2 \vec{g}$$

$$\text{TCI : } \vec{p}_2 = m_2 \vec{a}$$

$$\hookrightarrow m_2 \vec{a} = m_2 \vec{g} \Rightarrow \vec{a} = \vec{g}$$

$$\text{Par projection } \vec{a}' \begin{cases} a_x = 0 \\ a_y = -g \end{cases}$$

$$\vec{a}' = \frac{d\vec{v}}{dt} \Rightarrow \vec{v}' \begin{cases} v_x = c_1 \\ v_y = -gt + c_2 \end{cases}$$

$$\text{A } t=0; \vec{v}_2 \begin{cases} v_{2x} = c_1 = v_2 \\ v_{2y} = c_2 = 0 \end{cases}$$

$$\Rightarrow \vec{v}' \begin{cases} v_x = v_2 \\ v_y = -gt \end{cases}$$

$$\vec{v}' = \frac{d\vec{BG}}{dt} \Rightarrow \vec{BG}' \begin{cases} x = v_2 t + c_3 \\ y = -\frac{1}{2} g t^2 + c_4 \end{cases}$$

$$\text{A } t=0; \vec{BG}_0 \begin{cases} x_{B_2} = c_3 = 0 \\ y_{B_2} = c_4 = 0 \end{cases}$$

$$\Rightarrow \vec{BG}' \begin{cases} x = v_2 t \\ y = -\frac{1}{2} g t^2 \end{cases}$$

$$x = v_2 t \Rightarrow t = \frac{x}{v_2}$$

$$\Rightarrow y = -\frac{1}{2} g \left(\frac{x}{v_2} \right)^2$$

$$\Rightarrow y(x) = -\frac{g}{2v_2^2} x^2$$

$$5. \text{ Au point I : } y_I = H$$

$$\Rightarrow H = -\frac{g}{2v_2^2} x_I^2$$

$$\Rightarrow x_I = v_2 \sqrt{\frac{2H}{g}}$$

$$x_I = 1,62 \text{ m}$$

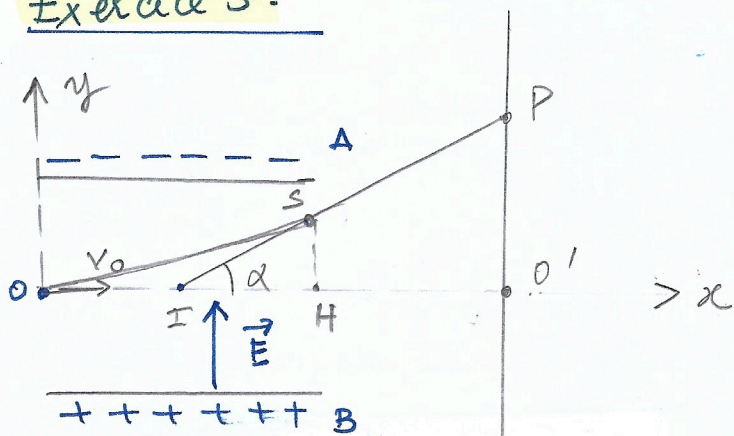
$$\text{La durée : } x_I = v_2 t_I$$

$$\Rightarrow t_I = \frac{x_I}{v_2} = \frac{1,62}{11,76} = 0,14 \text{ s}$$

$$t_I = 0,14 \text{ s}$$

(3)

Exercice 5:



1. Exprimons v_0 :

$$\text{T.E.C} : \frac{1}{2} m v_0^2 = q \cdot U_0$$

$$\Rightarrow v_0 = \sqrt{\frac{2qU_0}{m}}$$

2.1. Comme $U_{AB} < 0 \Rightarrow V_A - V_B < 0$
 $\Rightarrow V_A < V_B$ donc A(-) et B(+)

2.2. Equations horaires:

Système : particule

Ref : TSG

$$\text{B.F.A} : \vec{F}_e = q \vec{E}$$

$$\text{T.C.I} : \vec{F}_e = m \vec{a}' \Rightarrow q \vec{E} = m \vec{a}'$$

$$\Rightarrow \vec{a}' = \frac{q \vec{E}}{m}$$

$$\text{Par projection : } \vec{a}' \begin{cases} a_x = 0 \\ a_y = \frac{qE}{m} \end{cases}$$

$$\vec{a}' = \frac{d\vec{v}'}{dt} \Rightarrow \vec{v}' \begin{cases} v_x = v_0 \\ v_y = \frac{qE}{m} t \end{cases}$$

$$\vec{v}' = \frac{d\vec{OG}}{dt} \Rightarrow \vec{OG} \begin{cases} x = v_0 t \\ y = \frac{qE}{2m} t^2 \end{cases}$$

$$t = \frac{x}{v_0} \Rightarrow$$

$$y(x) = \frac{qE}{2m v_0^2} x^2$$

La trajectoire est parabolique.

2.3. Au point de sortie S: $x=l$

$$\Rightarrow y_s = -\frac{qEl^2}{2m v_0^2} \text{ or } E = \frac{U}{d}$$

$$\Rightarrow y_s = -\frac{qUl^2}{2m d v_0^2}$$

2.4. La particule émerge des plaques si: $y_s < \frac{d}{2}$

$$\Rightarrow \frac{qUl^2}{2m d v_0^2} < \frac{d}{2}$$

$$\Rightarrow U < \frac{2m d^2 \cdot v_0^2}{2qUl^2}$$

$$\Rightarrow U < \frac{m d^2 \cdot v_0^2}{qUl^2}$$

3.1. A la sortie des plaques la particule n'est soumise à aucune force $\Rightarrow m \vec{a}' = \vec{0}$
 $\Rightarrow v = \text{constante}$ - Donc son movt est rectiligne uniforme.

3.2. Expression de $y = O'P$

$$\tan \alpha = \frac{SH}{IH} = \frac{y}{IO'}$$

$$\Rightarrow y = \frac{SH \times IO'}{IH}$$

$$\Rightarrow y = \frac{\frac{qUl^2}{2m d v_0^2} \times D}{l/2}$$

$$\Rightarrow y = \frac{qUl^2 D}{m d v_0^2 l}$$

$$\Rightarrow y = \frac{qUlD}{m d v_0^2}$$

Exercice 6:

1. Théorème de Ec: La variation de l'énergie cinétique entre 2 points est égale à la somme des travaux des forces appliquées.

TEC entre B et A:

$$\frac{1}{2} m v_B^2 - \frac{1}{2} m v_A^2 = W(\vec{P}) + W(\vec{R}) + W(\vec{T})$$

$$\Rightarrow \frac{1}{2} m v_B^2 - \frac{1}{2} m v_A^2 = mgh \text{ avec } h = 2L$$

$$\Rightarrow v_B^2 - v_A^2 = 4gL$$

$$\Rightarrow v_B = \sqrt{v_A^2 + 4gL}$$

$$AN: v_B = \sqrt{(25)^2 + 4 \times 0,05 \times 0,5}$$

$$v_B = 25 \text{ m/s}$$

2. Valeur de la tension:

$$TCI: \vec{P} + \vec{T} = m\vec{a}$$

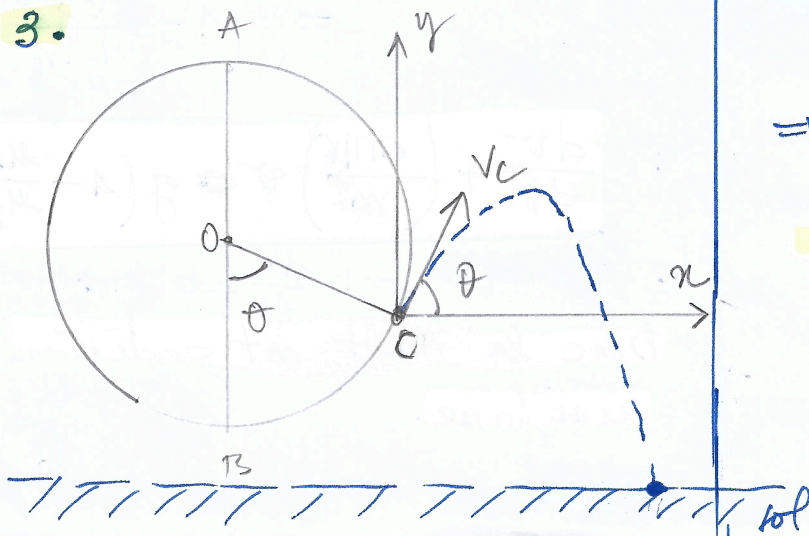
$$\text{suivant } \vec{m}: -P + T = m \cdot \frac{v_B^2}{L}$$

$$\Rightarrow T = m \left(g + \frac{v_B^2}{L} \right)$$

$$AN: T = 0,05 \left(9,8 + \frac{25^2}{0,5} \right) = 63 \text{ N}$$

$$T = 63 \text{ N}$$

3.



3.1. Equations de la trajectoire:

Système: fronde

Ref: TSG

BFA: $\vec{P}$

$$TCI: \vec{P}' = m\vec{a}' \Rightarrow \vec{a}' = \vec{g}$$

Dans le repère $(O, \vec{e}_1, \vec{e}_2)$

$$\vec{a}' \begin{cases} a_x = 0 \\ a_y = -g \end{cases}$$

$$\vec{a}' = \frac{d\vec{v}'}{dt} \Rightarrow \vec{v}' \begin{cases} v_x = c_1 \\ v_y = -gt + c_2 \end{cases}$$

$$\text{A } t=0; \vec{v}'_C \begin{cases} v_{Cx} = c_1 = v_C \cos \alpha \\ v_{Cy} = c_2 = v_C \sin \alpha \end{cases}$$

$$\Rightarrow \vec{v}' \begin{cases} v_x = v_C \cos \alpha \\ v_y = -gt + v_C \sin \alpha \end{cases}$$

$$\vec{v}' = \frac{d\vec{OC}'}{dt} \Rightarrow \vec{OC}' \begin{cases} x = (v_C \cos \alpha)t + c_3 \\ y = -\frac{1}{2}gt^2 + (v_C \sin \alpha)t + c_4 \end{cases}$$

$$\text{A } t=0; \vec{OC}'_0 \begin{cases} x_C = c_3 = 0 \\ y_C = c_4 = 0 \end{cases}$$

$$\Rightarrow \vec{OC}' \begin{cases} x = (v_C \cos \theta)t \\ y = -\frac{1}{2}gt^2 + (v_C \sin \theta)t \end{cases}$$

$$x = (v_C \cos \theta)t \Rightarrow t = \frac{x}{v_C \cos \theta}$$

$$\Rightarrow y = -\frac{1}{2}g \left(\frac{x}{v_C \cos \theta} \right)^2 + v_C \sin \theta \cdot \frac{x}{v_C \cos \theta}$$

$$\Rightarrow y(x) = -\frac{g}{2v_C^2 \cos^2 \theta} x^2 + (\tan \theta) x$$

$$3.2. \text{ Sur le sol } y_{\text{sol}} = -160 \text{ cm}$$

$$\Rightarrow -\frac{g}{2v_C^2 \cos^2 \theta} x^2 + (\tan \theta) x = -160$$

Calculons V_c :

$$TEC: \frac{1}{2} m (V_c^2 - V_B^2) = -mgh$$

$$\Rightarrow V_c^2 = V_B^2 - 2gl(1 - \cos \theta)$$

$$\Rightarrow V_c = \sqrt{V_B^2 - 2gl(1 - \cos \theta)}$$

$$AN: V_c = \sqrt{(25)^2 - 2 \times 9,8 \times 0,5 (1 - \cos 45^\circ)}$$

$$V_c = 24,9 \approx 25 \text{ m} \cdot \text{s}^{-1}$$

$$\Rightarrow -0,0157x^2 + x + 1,6 = 0$$

$$\Delta = 1^2 + 4 \times 1,6 \times 0,0157 = 1,1$$

$$x_1 = \frac{-1 + \sqrt{1,1}}{2(-0,0157)} = -1,155 \text{ (imp)}$$

$$x_2 = \frac{-1 - \sqrt{1,1}}{2(-0,0157)} = 65 \text{ m}$$

Donc le projectile tombe à 65 m.

3.3. Caractéristiques de $\vec{V}_{sol}$:

$$x_{sol} = V_c \cos \theta \cdot t_{sol}$$

$$\Rightarrow t_{sol} = \frac{x_{sol}}{V_c \cos \theta}$$

$$t_{sol} = \frac{65}{25 \times \cos 45^\circ} = 3,68 \text{ s}$$

$$\vec{V}_{sol} \begin{cases} V_x = V_c \cos \theta \\ V_y = -gt_{sol} + V_c \sin \theta \end{cases}$$

$$\Rightarrow \vec{V}_{sol} \begin{cases} V_x = 17,7 \\ V_y = -18,4 \end{cases}$$

$$V_{sol} = \sqrt{(17,7)^2 + (-18,4)^2}$$

$$V_{sol} = 25,5 \text{ m/s}$$

$$\tan \beta = \left| -\frac{V_y}{V_x} \right| = \frac{18,4}{17,7}$$

$$\Rightarrow \beta = 46,1^\circ$$

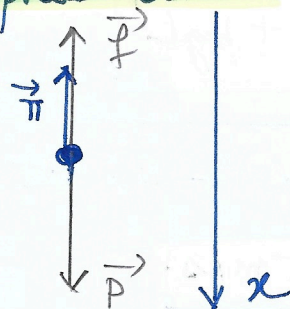
$\vec{V}_{sol}$ fait un angle de $46,1^\circ$ avec le sol.

Exercice 7:

1. BFA:

- le poids : $\vec{P} = m\vec{g}$
- frottement du fluide : $\vec{f}$
- Pousée d'Archimède : $\vec{\pi}$

Représentation:



2. Le début du mouvement est rectiligne accéléré.

$$3. \text{TCI: } \vec{P} + \vec{f} + \vec{\pi} = m\vec{a}$$

$$\text{Suivant } x: P - f - \pi = ma$$

$$\Rightarrow m \frac{dv}{dt} = mg - 6\pi\eta r v - \mu_s V_{sol} g$$

$$\Rightarrow \frac{dv}{dt} + \left(\frac{6\pi\eta r}{m} \right) v = g - \frac{\mu_s V_{sol} g}{m}$$

$$= g \left(1 - \frac{\mu_s V_{sol}}{\mu_g \cdot V_{sol}} \right)$$

$$\Rightarrow \frac{dv}{dt} + \left(\frac{6\pi\eta r}{m} \right) v = g \left(1 - \frac{\mu_s}{\mu_g} \right)$$

4. Si $a = 0 \Rightarrow \frac{dv}{dt} = 0 \Rightarrow v = \text{cte}$
Donc le mouvement est rectiligne uniforme.

(6)

5. Comme $\frac{dv}{dt} = 0 \Rightarrow$

$$\left(\frac{6\pi\eta r}{m}\right) v_{\text{lim}} = g \left(1 - \frac{\mu_s}{\mu_g}\right)$$

$$v_{\text{lim}} = g \cdot \frac{m}{6\pi\eta r} \cdot \left(1 - \frac{\mu_s}{\mu_g}\right)$$

$$\text{or } m = \rho_g \cdot V_{\text{sol}}$$

$$\Rightarrow v_{\text{lim}} = g \cdot \frac{\mu_g \cdot V_{\text{sol}}}{6\pi\eta r} \left(1 - \frac{\mu_s}{\mu_g}\right)$$

$$= g \cdot \frac{\frac{4\pi}{3} r^3}{6\pi\eta r} (\mu_g - \mu_s)$$

$$\Rightarrow v_{\text{lim}} = \frac{2r^2 g (\mu_g - \mu_s)}{9\eta}$$

AN: $v = 2,09 \cdot 10^{-6} \text{ m/s}$

$$v = 7,52 \text{ mm/h}$$

Cette personne ne présente pas de syndrome inflammatoire car la vitesse du globe rouge est inférieure à 10 mm/h.

Exercice 8:

1. Système : ballon

Ref: TSG

BFA: $\vec{D}'$

TCI: $\vec{D}' = m\vec{a}' \Rightarrow m\vec{a}' = m\vec{g}$

$$\Rightarrow \boxed{\vec{a}' = \vec{g}}$$

2. Par projection dans le repère

$$\vec{a} \begin{cases} a_x = 0 \\ a_y = -g \end{cases} \Rightarrow \vec{v} \begin{cases} v_x = v_0 \cos \alpha \\ v_y = gt + v_0 \sin \alpha \end{cases}$$

$$\Rightarrow \boxed{\vec{OG} \begin{cases} x = (v_0 \cos \alpha) t \\ y = -\frac{1}{2} g t^2 + (v_0 \sin \alpha) t + H \end{cases}}$$

3. $x = (v_0 \cos \alpha) t \Rightarrow t = \frac{x}{v_0 \cos \alpha}$

$$\Rightarrow y(x) = -\frac{1}{2} g \left(\frac{x}{v_0 \cos \alpha}\right)^2 + v_0 \sin \alpha \left(\frac{x}{v_0 \cos \alpha}\right) + H$$

$$\Rightarrow \boxed{y(x) = -\frac{g}{2v_0^2 \cos^2 \alpha} x^2 + (\tan \alpha) x + H}$$

Trajectoire parabolique.

4. Si la balle passe au dessus du gardien $x = 3 \text{ m}$

$$\Rightarrow y = -\frac{9,8 \times (3)^2}{2(7)^2 \cos^2 60} + (\tan 60) \times 3 + 2,8$$

$$\boxed{y = 4,18 \text{ m}}$$

$y > 2,4 \text{ m}$ donc le gardien est lobe!

5. Si le but est marqué

$$x = D \text{ et } y(D) < 2,0 \text{ m}$$

$$y(D) = -\frac{9,8(5)^2}{2(7)^2 \cos^2 60} + (\tan 60) \times 5 + 2,8$$

$$y(D) = 1,46 \text{ m} < 2,0 \text{ m} \text{ donc}$$

le but est bien marqué.

6. $0 \leq y(D) < 2,0 \text{ m}$

$$\Rightarrow 0 \leq -\frac{gD^2}{2v_0^2 \cos^2 60} + (\tan 60)D + H < 2,0$$

$$\Rightarrow -D \tan 60 - H \leq -\frac{gD^2}{2v_0^2 \cos^2 60} < 2,0 - D \tan 60 - H$$

$$\frac{1}{D \tan 60 + H} \leq \frac{2v_0^2 \cos^2 60}{gD^2} < \frac{1}{D \tan 60 + H - 2}$$

$$\frac{1}{2 \cos^2 60 (D \tan 60 + H)} \leq v_0^2 < \frac{1}{2 \cos^2 60 (D \tan 60 + H - 2)}$$

$$\sqrt{\frac{gD^2}{2\cos^2\alpha(D\tan 60^\circ + H)}} \leq v_0 < \sqrt{\frac{gD^2}{2\cos^2\alpha(D\tan 60^\circ + H - 2)}}$$

$$6,53 \text{ m/s} \leq v_0 < 8,10 \text{ m/s}$$

Exercice 9:

1. $\vec{V}_c$ est horizontale et dirigée vers la droite.

2. Equation de la trajectoire

Système: balle

Ref: TSG

$$\text{BFA: } \vec{P} = m\vec{g}$$

$$\text{TCI: } \vec{P} = m\vec{a}' \Rightarrow m\vec{g} = m\vec{a}'$$

$$\Rightarrow \vec{a}' = \vec{g}$$

Par projection: $\vec{a} \begin{cases} a_x = 0 \\ a_y = +g \end{cases}$

$$\vec{a}' = \frac{d\vec{v}}{dt} \Rightarrow \vec{v} \begin{cases} v_x = c_1 \\ v_z = +gt + c_2 \end{cases}$$

$$\text{A } t=0; \vec{v}_c \begin{cases} v_{cx} = c_1 = v_c \\ v_{cy} = c_2 = 0 \end{cases}$$

$$\Rightarrow \vec{v} \begin{cases} v_x = v_c \\ v_y = -gt \end{cases}$$

$$\vec{v} = \frac{d\vec{OG}}{dt} \Rightarrow \vec{OG} \begin{cases} x = v_c t + c_3 \\ z = +\frac{1}{2}gt^2 + c_4 \end{cases}$$

$$\text{A } t=0; \vec{OC} \begin{cases} x_c = c_3 = 0 \\ z_c = c_4 = 0 \end{cases}$$

$$\Rightarrow \vec{OC} \begin{cases} x = v_c t \\ z = \frac{1}{2}gt^2 \end{cases}$$

$$x = v_c t \Rightarrow t = \frac{x}{v_c}$$

$$\Rightarrow z(x) = \frac{g}{2v_c^2} x^2$$

3. Expression de V_c

Au point D: $\begin{cases} z_D = 2r \\ x_D = BD = L \end{cases}$

$$\Rightarrow 2r = \frac{gL^2}{2v_c^2}$$

$$(\Rightarrow 4rv_c^2 = gL^2 \Rightarrow v_c^2 = \frac{gL^2}{4r})$$

$$\Rightarrow v_c = \frac{L}{2} \sqrt{\frac{g}{r}}$$

$$\text{AN: } v_c = \frac{1}{2} \times \sqrt{\frac{9,8}{0,3}}$$

$$v_c = 2,86 \text{ m/s}$$

4. Relation entre v_c et v_B

TEC entre B et C:

$$\frac{1}{2}m(v_c^2 - v_B^2) = -mg(2r)$$

$$\Rightarrow v_c^2 - v_B^2 = -4gr$$

$$\Rightarrow v_B = \sqrt{v_c^2 + 4gr}$$

5. Entre A et B, aucune force ne travaille. donc $\Delta E_c = 0$

$$E_{cB} - E_{cA} = 0 \rightarrow E_{cB} = E_{cA}$$

$$\frac{1}{2}mv_B^2 = \frac{1}{2}mv_A^2 \Rightarrow v_B^2 = v_A^2$$

$$\Rightarrow v_B = v_A$$

Entre A et B le MRU.

$$6. v_A = v_B = \sqrt{v_c^2 + 4gr}$$

$$v_A = \sqrt{(2,86)^2 + 4 \times 9,8 \times 0,3}$$

$$v_A = 4,47 \text{ m/s}$$

7. Calculons v_A' :

TEC entre A et C:

$$\frac{1}{2} m (v_c^2 - v_A'^2) = W_{ABC}(f) + W_{BC}(\vec{P})$$

$$= -f \left(l + r \frac{\pi}{2} \right) - mg(2r)$$

$$\Rightarrow m(v_c^2 - v_A'^2) = -2f \left(l + r \frac{\pi}{2} \right) - 4mgr$$

$$\Rightarrow v_c^2 - v_A'^2 = -\frac{2f}{m} \left(l + r \frac{\pi}{2} \right) - 4gr$$

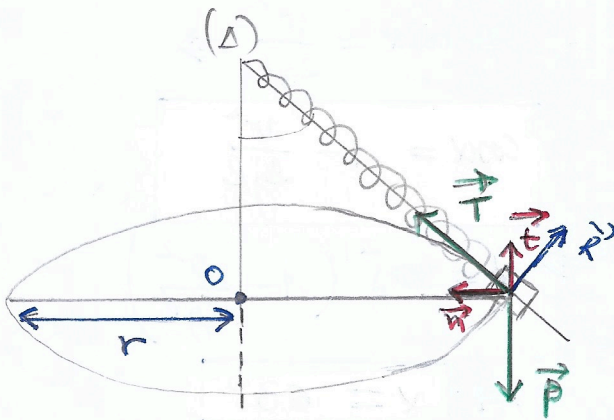
$$\Rightarrow v_A'^2 = v_c^2 + \frac{2f}{m} \left(l + r \frac{\pi}{2} \right) + 4gr$$

$$v_A' = \sqrt{v_c^2 + \frac{2f}{m} \left(l + r \frac{\pi}{2} \right) + 4gr}$$

$$AN: v_A' = \sqrt{(2,86)^2 + \frac{2 \times 0,1}{0,0459} \left(0,9 + 0,3 \times \frac{\pi}{2} \right) + 4 \times 9,8 \times 0,3}$$

$$v_A' = 5,1 \text{ m/s.}$$

Exercice 10:



1. Système: solide

Ref: TSG

BFA: $\vec{P}$; $\vec{T}$ et $\vec{R}$

TCI: $\vec{P}' + \vec{R}' + \vec{T}' = m\vec{a}$

Suivant m: $T \sin \alpha - R \cos \alpha = m a_n$

Suivant t: $-P + T \cos \alpha + R \sin \alpha = 0$

$$T = \frac{mg - R \sin \alpha}{\cos \alpha}$$

$$AN: T = 2,1 \text{ N}$$

$$3/ T \sin \alpha - R \cos \alpha = m r \omega^2$$

$$\omega^2 = \frac{T \sin \alpha - R \cos \alpha}{m r}$$

$$r = l \sin \alpha = \left(l_0 + x \right) \sin \alpha$$

$$r = \left(l_0 + \frac{I}{k} \right) \sin \alpha$$

$$\Rightarrow \omega^2 = \frac{T \sin \alpha - R \cos \alpha}{\left(l_0 + \frac{I}{k} \right) \sin \alpha}$$

$$\Rightarrow \omega = \sqrt{\frac{T \sin \alpha - R \cos \alpha}{\left(l_0 + \frac{I}{k} \right) \sin \alpha}}$$

$$AN: \omega = 5,77 \text{ rad/s}$$

$$v = r \omega$$

$$v = \left(l_0 + \frac{I}{k} \right) \sin \alpha \times \omega$$

$$AN: v = 0,71 \text{ m/s}$$

$$a = a_n = \frac{v^2}{r}$$

$$a = \frac{v^2}{\left(l_0 + \frac{I}{k} \right) \sin \alpha}$$

$$AN: a = 4,10 \text{ m/s}^2$$

Exercice 11:

1. Système: missile

Ref: TSG

BFA: $\vec{P}' = m\vec{g}$

TCI: $m\vec{g}' = m\vec{a}' \Rightarrow \vec{a}' = \vec{g}$

Par projection on $\vec{a}$:

$$\vec{a}' \begin{cases} a_x = 0 \\ a_y = -g \end{cases}$$

$$2. \vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \vec{v} \begin{cases} v_x = c_1 \\ v_y = -gt + c_2 \end{cases}$$

$$\text{A } t=0, \vec{v}_0 \begin{cases} v_{0x} = c_1 = v_0 \cos \alpha \\ v_{0y} = c_2 = v_0 \sin \alpha \end{cases}$$

$$\Rightarrow \boxed{\vec{v} \begin{cases} v_x = v_0 \cos \alpha \\ v_y = -gt + v_0 \sin \alpha \end{cases}}$$

$v_x = \text{cste}$: MU suivant x

$v_y = -gt + v_0 \sin \alpha$: MUV suivant y

$$\vec{v} = \frac{d\vec{OG}}{dt} \Rightarrow \vec{OG} \begin{cases} x = (v_0 \cos \alpha)t + c_3 \\ y = -\frac{1}{2}gt^2 + (v_0 \sin \alpha)t + c_4 \end{cases}$$

$$\text{A } t=0; \vec{OG}_0 \begin{cases} x_0 = c_3 = 0 \\ y_0 = c_4 = 0 \end{cases}$$

$$\Rightarrow \boxed{\vec{OG} \begin{cases} x = (v_0 \cos \alpha)t \\ y = -\frac{1}{2}gt^2 + (v_0 \sin \alpha)t \end{cases}}$$

$$3. V_0 = 7 V_{\text{km}} \\ = 7 \times 330$$

$$\boxed{V_0 = 2310 \text{ m/s}}$$

$$4. D = \frac{V_0^2 \sin(2\alpha)}{g}$$

D est maximale si $\sin(2\alpha) = 1$

$$\Rightarrow 2\alpha = 90 \Rightarrow \alpha = 45^\circ$$

$$D = \frac{(2310)^2}{9,8}$$

$$\boxed{D = 5,45 \cdot 10^5 \text{ m}}$$

$$5. x = D = (v_0 \cos \alpha)t \Rightarrow$$

$$\boxed{t = \frac{D}{v_0 \cos \alpha}}$$

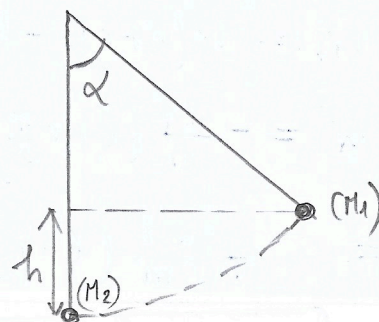
$$t = \frac{5145 \cdot 10^4}{2310 \times \cos 45}$$

$$\boxed{t = 333 \text{ s}}$$

6. Il est difficile de se protéger contre ses missiles car ils sont très rapides.

Exercice 12:

1. Calcul de α :



Système: M_1

Ref: TSG

BFA: $\vec{P}'$ et $\vec{T}$

$$\text{TEC: } \frac{1}{2}mv^2 - \frac{1}{2}mv_i^2 = W(\vec{P}') + W(\vec{T})$$

$$\Rightarrow \frac{1}{2}mv^2 = mgl(1 - \cos \alpha)$$

$$\Rightarrow 1 - \cos \alpha = \frac{v^2}{2gl} \Rightarrow$$

$$\boxed{\cos \alpha = 1 - \frac{v^2}{2gl}}$$

$$\Rightarrow \alpha = \cos^{-1}\left(1 - \frac{v^2}{2gl}\right)$$

$$\text{AN: } \boxed{\alpha = 63^\circ}$$

2. Avant le choc:

$$\vec{P}_{\text{avant}} = m_1 \vec{v}$$

Après le choc:

$$\vec{P}_{\text{après}} = m_1 \vec{v}_1 + m_2 \vec{v}_A$$

Conservation de la quantité de mouvement:

$$\vec{P}_{\text{avant}} = \vec{P}_{\text{après}}$$

$$\Rightarrow m_1 \vec{v} = m_1 \vec{v}' + m_2 \vec{v}_A$$

Dans le sens du mouvement :

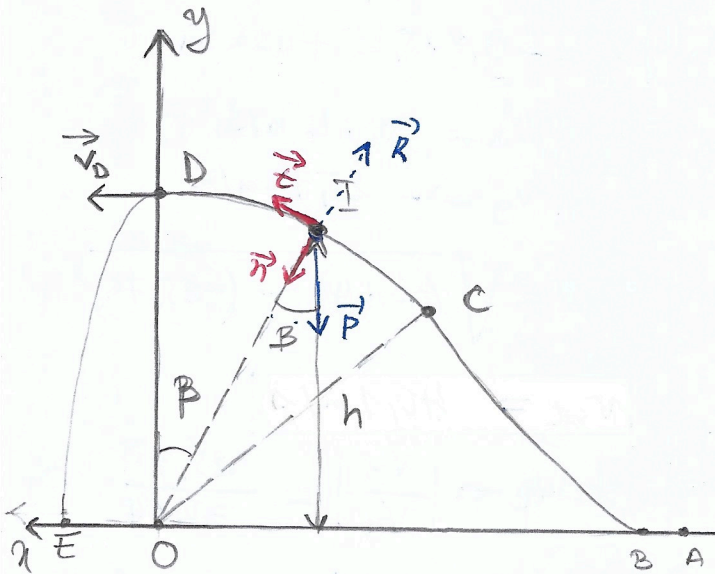
$$m_1 v = m_1 v' + m_2 v_A$$

$$\Rightarrow v' = \frac{m_1 v - m_2 v_A}{m_1}$$

$$AN: v_1' = 1,0 \text{ m/s.}$$

3.1. TEE:

$$\frac{1}{2} m (v_I^2 - v_A^2) = -mgh$$



or $h = r \cos \beta \Rightarrow$

$$v_I^2 - v_A^2 = -2gr \cos \beta$$

$$\Rightarrow v_I = \sqrt{v_A^2 - 2gr \cos \beta}$$

3.2. TCI: $\vec{P} + \vec{R} = m\vec{a}$

Suivant $\vec{n}$: $+P \cos \beta - R = m a_n$

$$\Rightarrow R = mg \cos \beta - m \cdot \frac{v_I^2}{r}$$

$$= mg \cos \beta - m \left(\frac{v_A^2}{r} - 2g \cos \beta \right)$$

$$\Rightarrow R = m \left(3g \cos \beta - \frac{v_A^2}{r} \right)$$

$$3.3. \text{TEC}: \frac{1}{2} m (v_D^2 - v_A^2) = -mgh$$

$$\text{or } h = r$$

$$\Rightarrow v_D^2 - v_A^2 = -2gr$$

$$\Rightarrow r = \frac{v_A^2 - v_D^2}{2g}$$

$$AN: r = 0,75 \text{ m}$$

4) 1. TCI: $\vec{P} = m\vec{a} \Rightarrow \vec{a} = \vec{g}$

Par project² $\vec{a} \begin{cases} a_x = 0 \\ a_y = -g \end{cases}$

$$\Rightarrow \vec{v} \begin{cases} v_x = v_D \\ v_y = -gt \end{cases}$$

$$\Rightarrow \vec{OG} \begin{cases} x = v_D t \\ y = -\frac{1}{2} g t^2 + r \end{cases}$$

$$x = v_D t \Rightarrow t = \frac{x}{v_D}$$

$$\Rightarrow y(x) = -\frac{1}{2} g \left(\frac{x}{v_D} \right)^2 + r$$

$$\Rightarrow y(x) = -\frac{g}{2v_D^2} x^2 + r$$

4.2. Calculons OE:

Au sol $y = 0 \Rightarrow$

$$-\frac{g}{2v_D^2} x_E^2 + r = 0$$

$$\Rightarrow x_E = v_D^2 \sqrt{\frac{2r}{g}}$$

$$AN: x_E = 1 \sqrt{\frac{2 \times 0,75}{9,8}}$$

$$x_E = OE = 0,39 \text{ m}$$

Exercice 13:

1.1. Equations horaires:

Système: balle

Ref: TSG

BFA: $\vec{P}' = m\vec{g}$

TCI: $\vec{P}' = m\vec{a}' \Rightarrow \vec{a} = \vec{g}$

Par projection $\vec{a} \begin{cases} a_x = 0 \\ a_y = -g \end{cases}$

$\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \vec{v} \begin{cases} v_x = c_1 \\ v_y = -gt + c_2 \end{cases}$

At=0 $\vec{v}_0 \begin{cases} v_{0x} = c_1 = v_0 \cos \alpha \\ v_{0y} = c_2 = v_0 \sin \alpha \end{cases}$

$\Rightarrow \vec{v} \begin{cases} v_x = v_0 \cos \alpha \\ v_y = -gt + v_0 \sin \alpha \end{cases}$

$\vec{v} = \frac{d\vec{OG}}{dt} \Rightarrow \vec{OG} \begin{cases} x = (v_0 \cos \alpha)t + c_3 \\ y = -\frac{g}{2}t^2 + (v_0 \sin \alpha)t + c_4 \end{cases}$

At=0 $\vec{v}_0 \begin{cases} x_0 = c_3 = 0 \\ y_0 = c_4 = 0 \end{cases}$

$\Rightarrow \vec{OG} \begin{cases} x = (v_0 \cos \alpha)t \\ y = -\frac{1}{2}gt^2 + (v_0 \sin \alpha)t \end{cases}$

1.2. Equation de la trajectoire:

$x = (v_0 \cos \alpha)t \Rightarrow t = \frac{x}{v_0 \cos \alpha}$

$\hookrightarrow y(x) = -\frac{g}{2v_0^2 \cos^2 \alpha} x^2 + (\tan \alpha)x$

1.3. Expression de la portée:

$y=0 \Rightarrow -\frac{g}{2v_0^2 \cos^2 \alpha} x_p^2 + (\tan \alpha)x_p = 0$

$\Rightarrow +gx_p = 2v_0^2 \cos^2 \alpha - \frac{g \sin \alpha}{\cos \alpha}$

$\Rightarrow g = v_0^2 \sin(2\alpha)$

$\Rightarrow x_p = \frac{v_0^2 \sin(2\alpha)}{g}$

AN: $x_p = \frac{(40)^2 \times \sin(80)}{9,8}$

$x_p = 161 \text{ m}$

1.4. Caractéristiques de $\vec{v}_{\text{sol}}$

$x_p = (v_0 \cos \alpha) t_p \Rightarrow t_p = \frac{x_p}{v_0 \cos \alpha}$

AN: $t_p = \frac{161}{40 \times \cos 40} \approx 5,25 \text{ s}$

$\vec{v}_{\text{sol}} \begin{cases} v_x = 40 \times \cos 40^\circ \\ v_y = -9,8 \times 5,25 + 40 \times \sin 40^\circ \end{cases}$

$\Rightarrow \vec{v}_{\text{sol}} \begin{cases} v_x = 30,64 \text{ m/s} \\ v_y = -25,74 \text{ m/s} \end{cases}$

$v_{\text{sol}} = \sqrt{(30,64)^2 + (-25,74)^2}$

$v_{\text{sol}} = 40,1 \text{ m/s}$

$\tan \beta = \left| \frac{v_y}{v_x} \right| = \frac{25,74}{30,64}$

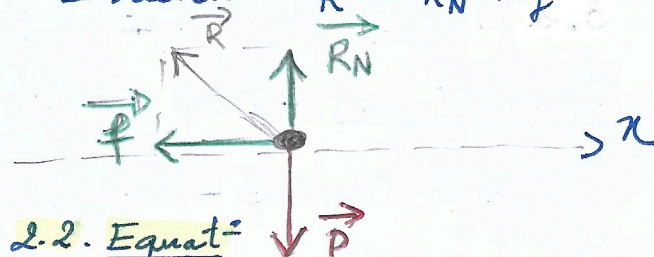
$\Rightarrow \beta = 40^\circ$

$\vec{v}_{\text{sol}}$ fait 40° avec le sol.

2.1. Bilan des forces:

- poids $\vec{P}'$

- réaction $\vec{R}' = \vec{R}_N + \vec{f}$



2.2. Equat:

TCI: $\vec{P}' + \vec{R}' = m\vec{a}_1$

Suivant x: $0 - f = m a_1$

$\Rightarrow a_1 = -\frac{f}{m}$

$$a_1 = \frac{dv_x}{dt} \Rightarrow v_x = -\frac{f}{m}t + C_1$$

$$\text{A } t=0; v_0 = C_1$$

$$\Rightarrow v_x = -\frac{f}{m}t + v_0$$

$$v_x = \frac{dx_1}{dt} \Rightarrow x_1 = -\frac{f}{2m}t^2 + v_0t + C_2$$

$$\text{A } t=0; x_0 = 0 = C_2$$

$$\Rightarrow x_1 = -\frac{f}{2m}t^2 + v_0t$$

2.3. Distance parcourue par la balle:

Si la balle s'arrete: $v_x = 0$

$$\hookrightarrow -\frac{f}{m}t + v_0 = 0$$

$$\Rightarrow t = \frac{mv_0}{f}$$

$$t = \frac{0,045 \times 3,2}{5 \cdot 10^{-2}} = 2,88 \text{ s}$$

$$d = x_1 = -\frac{5 \cdot 10^{-2}}{2 \times 0,045} \times (2,88)^2 + 3,2 \times (2,88)$$

$$d = 4,61 \text{ m}$$

L'approche est pas réussie si

$$5 - 0,108 < d < 5 + 0,108$$

$$4,892 \text{ m} < d < 5,108 \text{ m}$$

$d \notin$ pas à cet intervalle donc l'approche n'est pas réussie.

Exercice 14:

1.1. Accélération:

Système: solide

Ref: TSG

BFA: $\vec{P}$; $\vec{R}$

$$\text{TCI: } \vec{P} + \vec{R} = m\vec{a}$$

Suivant le plan incliné:

$$mg \sin \alpha = ma \Rightarrow a = g \sin \alpha$$

$$\text{AN: } a = 10 \times \sin(30)$$

$$a = 5 \text{ m/s}^2$$

1.2. Vitesse au point B:

$$\frac{1}{2}m(v_B^2 - v_A^2) = W(\vec{P}) + W(\vec{R})$$

$$\Rightarrow \frac{1}{2}m(v_B^2 - v_A^2) = mgL_1 \sin \alpha$$

$$\Rightarrow v_B = \sqrt{2gL_1 \sin \alpha}$$

$$\text{AN: } v_B = \sqrt{2 \times 10 \times 2 \times \sin(30)}$$

$$v_B = 4,47 \text{ m/s}$$

1.3. Durée du trajet AB:

$$a = 5 \text{ m/s}^2 \Rightarrow v = at$$

$$\text{Au point B: } v_B = at_B$$

$$\Rightarrow t_B = \frac{v_B}{a}$$

$$\text{AN: } t_B = \frac{4,47}{5} = 0,89 \text{ s}$$

$$t_B = 0,89 \text{ s}$$

2. Déterminons f :

$$\text{TEC: } -\frac{1}{2}mv_c^2 = W(\vec{P}) + W(\vec{f})$$

$$\Rightarrow -\frac{1}{2}mv_c^2 = -fxL_2$$

$$\Rightarrow mv_c^2 = 2fL_2$$

$$\Rightarrow f = \frac{mv_c^2}{2L_2}$$

$$\text{AN: } f = \frac{0,5 \times (4,47)^2}{2 \times 3}$$

$$f = 1,67 \text{ N}$$

3.1. TEI au point C:

$$\vec{P} + \vec{R} = m\vec{a}$$

$$\text{Suivant } \vec{n}: -mg \sin \theta + R = ma_n \quad (13)$$

$$\rightarrow R = mg \sin \theta + m \cdot \frac{v^2}{r}$$

Expression de v^2 :

$$\text{TEC: } \frac{1}{2} m v^2 = m g r \sin \theta$$

$$\Rightarrow v^2 = 2 g r \sin \theta$$

$$\rightarrow R = m g r \sin \theta + 2 m g r \sin \theta$$

$$\Rightarrow \boxed{R = 3 m g \sin \theta}$$

3.2. Calculons v_0 et R_0 :

$$v = \sqrt{2 g r \sin \theta}$$

$$\text{Au point O: } \theta = \frac{\pi}{2} + \alpha$$

$$\Rightarrow v_0 = \sqrt{2 g r \sin \left(\frac{\pi}{2} + \alpha \right)}$$

$$\text{or } \sin \left(\frac{\pi}{2} + \alpha \right) = \cos \alpha$$

$$\Rightarrow \boxed{v_0 = \sqrt{2 g r \cos \alpha}}$$

$$\text{AN: } v_0 = \sqrt{2 \times 10 \times 2 \times \cos 30}$$

$$\boxed{v_0 = 5,89 \text{ m/s}}$$

$$R_0 = 3 m g \sin \left(\frac{\pi}{2} + \alpha \right)$$

$$\Rightarrow \boxed{R_0 = 3 m g \cos \alpha}$$

$$\text{AN: } R_0 = 3 \times 0,5 \times 10 \times \cos(30)$$

$$\boxed{R_0 = 13 \text{ N}}$$

4.1. Equations horaires:

Système: solide

Ref: TSG

$$\text{BFA: } \vec{P}' = m \vec{g}'$$

$$\text{TCI: } \vec{P}' = m \vec{a}' \Rightarrow \vec{a} = \vec{g}$$

$$\text{Par projection: } \vec{a}' \begin{cases} a_x = 0 \\ a_y = -g \end{cases}$$

$$\vec{a}' = \frac{d\vec{v}'}{dt} \Rightarrow \vec{v}' \begin{cases} v_x = c_1 = v_0 \cos \alpha \\ v_y = -g t + v_0 \sin \alpha \end{cases}$$

$$\vec{a}' = \frac{d\vec{OG}'}{dt} \Rightarrow \vec{OG}' \begin{cases} x = (v_0 \cos \alpha) t + c_3 \\ y = -\frac{g}{2} t^2 + (v_0 \sin \alpha) t + c_4 \end{cases}$$

$$\text{A } t=0; \vec{OG}'_0 \begin{cases} x_0 = c_3 = 0 \\ y_0 = c_4 = 0 \end{cases}$$

$$\rightarrow \boxed{\vec{OG}' \begin{cases} x = (v_0 \cos \alpha) t \\ y = -\frac{g}{2} t^2 + (v_0 \sin \alpha) t \end{cases}}$$

Equation de la trajectoire:

$$x = v_0 \cos \alpha t \Rightarrow t = \frac{x}{v_0 \cos \alpha}$$

$$\rightarrow \boxed{y(x) = -\frac{g}{2 v_0^2 \cos^2 \alpha} x^2 + (\tan \alpha) x}$$

4.2. Déterminons O'D.

$$\text{Au point D: } y = H - r \cos \alpha$$

$$\Rightarrow -\frac{g}{2 v_0^2 \cos^2 \alpha} x^2 + (\tan \alpha) x = -(H - r \cos \alpha)$$

$$\Rightarrow -\frac{g}{2 v_0^2 \cos^2 \alpha} x^2 + (\tan \alpha) x + H - r \cos \alpha = 0$$

$$\Rightarrow -0,185 x^2 + 0,58 x + 0,77 = 0$$

$$\Delta = 0,91$$

$$x_1 = \frac{-0,58 + \sqrt{0,91}}{2(-0,185)} = -1,0 < 0$$

$$x_2 = \frac{-0,58 - \sqrt{0,91}}{2(-0,185)} = 4,15 \text{ m}$$

$$\text{Donc } \boxed{\text{O'D} = 4,15 \text{ m}}$$

Exercice 15:

1.1. Calculons v_B ; v_C et v_D :

TEC entre A et B:

$$\frac{1}{2} m v_B^2 = mg AB \sin \alpha$$

$$\Rightarrow v_B = \sqrt{2g \cdot AB \cdot \sin \alpha}$$

$$\text{AN: } v_B = \sqrt{2 \times 10 \times 1,6 \times \sin(30^\circ)}$$

$$v_B = 4 \text{ m/s}$$

TEC entre B et C:

$$\frac{1}{2} m (v_C^2 - v_B^2) = mgr(1 - \cos \alpha)$$

$$\Rightarrow v_C = \sqrt{v_B^2 + 2gr(1 - \cos \alpha)}$$

$$\text{AN: } v_C = \sqrt{(4)^2 + 2 \times 10 \times 0,9(1 - \cos 30^\circ)}$$

$$v_C = 4,3 \text{ m/s}$$

TEC entre C et D:

$$\frac{1}{2} m (v_D^2 - v_C^2) = -mgr(1 - \sin \alpha)$$

$$\Rightarrow v_D = \sqrt{v_C^2 - 2gr(1 - \sin \alpha)}$$

$$\text{AN: } v_D = \sqrt{(4,3)^2 - 2 \times 10 \times 0,9(1 - \sin 30^\circ)}$$

$$v_D = 3,1 \text{ m/s}$$

1.2. Intensité de la réaction:

$$\text{TCI: } \vec{P}' + \vec{R}' = m\vec{a}'$$

$$\text{Suivant } \vec{n}: -mg + R_c = m \cdot \frac{v_C^2}{r}$$

$$\Rightarrow R_c = m \left(g + \frac{v_C^2}{r} \right)$$

$$\text{AN: } R_c = 0,05 \left(10 + \frac{(4,3)^2}{0,9} \right)$$

$$\textcircled{15} \quad R_c = 1,53 \text{ N}$$

$$\text{Au point D: } -mg \sin \alpha + R = m a_n$$

$$\Rightarrow R = mg \sin \alpha + m \cdot \frac{v_D^2}{r}$$

$$R = m \left(g \sin \alpha + \frac{v_D^2}{r} \right)$$

$$\text{AN: } R = 0,05 \left(10 \times \sin(30^\circ) + \frac{(3,1)^2}{0,9} \right)$$

$$R_D = 0,75 \text{ N}$$

1.3. Caractéristiques de $\vec{v}_D$:

$\vec{v}_D$ est tangente à la trajectoire et fait un angle de 30° avec l'horizontale.

$$v_D = 3,1 \text{ m/s}$$

2.1. Equation cartésienne:

Système: solide

Ref: TSG

$$\text{BFA: } \vec{P} = m\vec{g}$$

$$\text{TCI: } \vec{P} = m\vec{a}' \Rightarrow \vec{a}' = \vec{g}$$

Par projection:

$$\vec{a}' \begin{cases} a_x = 0 \\ a_y = -g \end{cases}$$

$$\vec{a}' = \frac{d\vec{v}}{dt} \Rightarrow \vec{v} \begin{cases} v_x = c_1 \\ v_y = -gt + c_2 \end{cases}$$

$$\text{A } t=0; \vec{v}_D \begin{cases} v_{Dx} = c_1 = v_D \cos \alpha \\ v_{Dy} = c_2 = v_D \sin \alpha \end{cases}$$

$$\hookrightarrow \vec{v} \begin{cases} v_x = v_D \cos \alpha \\ v_y = -gt + v_D \sin \alpha \end{cases}$$

$$\vec{v} = \frac{d\vec{OG}}{dt} \Rightarrow \vec{OG} \begin{cases} x = (v_D \cos \alpha)t + c_3 \\ z = -\frac{g}{2}t^2 + (v_D \sin \alpha)t + c_4 \end{cases}$$

$$A. t=0; \vec{GD}_0 \begin{cases} x_D = 0 = C_3 \\ z_D = h + r(1 - \sin \alpha) = C_4 \end{cases}$$

$$\Rightarrow \vec{DG} \begin{cases} x = (v_D \cos \alpha) t \\ z = -\frac{g}{2} t^2 + (v_D \sin \alpha) t + h + r(1 - \sin \alpha) \end{cases}$$

$$x = (v_D \cos \alpha) t \Rightarrow t = \frac{x}{v_D \cos \alpha}$$

$$\hookrightarrow \boxed{Z(x) = \frac{-g}{2v_D^2 \cos^2 \alpha} x^2 + (\tan \alpha) x + h + r(1 - \sin \alpha)}$$

2.2. Au point le plus haut $v_z = 0$

$$\Rightarrow -gt_H + v_D \sin \alpha = 0$$

$$\hookrightarrow t_H = \frac{v_D \sin \alpha}{g}$$

$$\Rightarrow \boxed{H = \frac{v_D^2 \sin^2(\alpha)}{2g} + h + r(1 - \sin \alpha)}$$

$$AN: H = \frac{(3,1)^2 \sin^2(30)}{2 \times 10} + 1,5 + 0,9(1 - \sin 30) \quad \text{Exercice 16:}$$

$$\boxed{H = 2,12 \text{ m}}$$

2.3. Déterminons OP:

Au sol $z = 0 \Rightarrow$

$$\frac{-g}{2v_D^2 \cos^2 \alpha} x_p^2 + (\tan \alpha) x_p + h + r(1 - \sin \alpha) = 0$$

$$\Rightarrow -0,694 x_p^2 + 0,58 x_p + 2,10 = 0$$

$$\Delta = 6$$

$$x_{p1} = \frac{-0,58 + \sqrt{6}}{2(-0,694)} = -1,5 < 0$$

$$x_{p2} = \frac{-0,58 - \sqrt{6}}{2(-0,694)} = 2,18 \text{ m}$$

$$\text{Donc } \boxed{OP = 2,18 \text{ m}}$$

3.1. Expression de $W(\vec{f})$:

TEC entre A et D:

$$\Delta E_c = W(\vec{P}) + W(\vec{f})$$

$$0 = mgr \sin \alpha + W(\vec{f})$$

$$\Rightarrow W(\vec{f}) = -mgr \sin \alpha$$

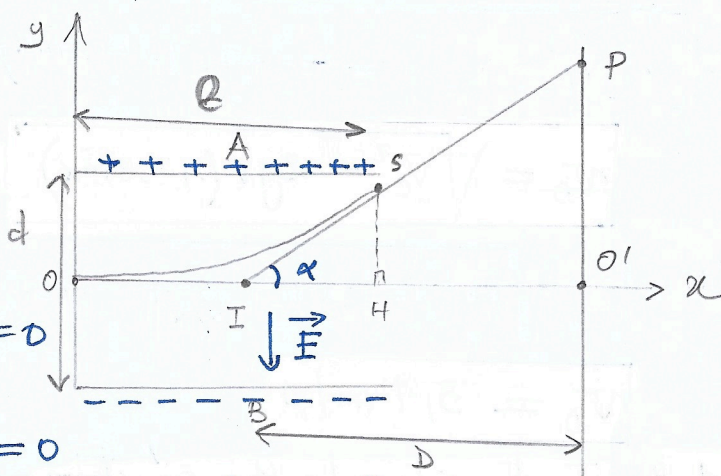
$$\boxed{W(\vec{f}) = -f \left(AB + \frac{\pi}{2} r \right)}$$

$$\Rightarrow -f \left(AB + \frac{\pi}{2} r \right) = -mgr \sin \alpha$$

$$\Rightarrow \boxed{f = \frac{mgr \sin \alpha}{AB + \frac{\pi}{2} r}}$$

$$AN: f = \frac{0,05 \times 10 \times 0,90 \times \sin(30)}{1,6 + \frac{\pi}{2} \times 0,9}$$

$$\boxed{f = 0,075 \text{ N}}$$



1. Equations horaires:

$$U_{AB} > 0 \Rightarrow v_A - v_B > 0 \Rightarrow v_A > v_B$$

Système: particule

Ref: TSG

$$BFA: \vec{F} = q\vec{E}$$

$$TCI: q\vec{E} = m\vec{a} \Rightarrow \vec{a} = \frac{q\vec{E}}{m}$$

$$\text{Par projet: } \vec{a} \begin{cases} a_x = 0 \\ a_y = \frac{-qE}{m} = \frac{-qU}{md} \end{cases}$$

$$\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \vec{v} = \begin{cases} v_x = C_1 \\ v_y = \frac{-qU}{md}t + C_2 \end{cases}$$

$$\text{À } t=0; \vec{v}_0 \begin{cases} v_{0x} = C_1 = v_0 \\ v_{0y} = C_2 = 0 \end{cases}$$

$$\hookrightarrow \vec{v} \begin{cases} v_x = v_0 \\ v_y = \frac{-qU}{md} \cdot t \end{cases}$$

$$\vec{v} = \frac{d\vec{OG}}{dt} \Rightarrow \vec{OG} \begin{cases} x = v_0 t + C_3 \\ y = \frac{-qU}{2m} t^2 + C_4 \end{cases}$$

$$\text{À } t=0; \vec{OG}_0 \begin{cases} x_0 = C_3 = 0 \\ y_0 = C_4 = 0 \end{cases}$$

$$\hookrightarrow \vec{OG} \begin{cases} x = v_0 t \\ y = -\frac{qU}{2m} \cdot t^2 \end{cases}$$

Equation de la trajectoire:

$$t = \frac{x}{v_0} \Rightarrow y(x) = \frac{-qU}{2mdv_0^2} x^2$$

2. La déviation angulaire:

$$\tan \alpha = \frac{SH}{IH} \text{ or } SH = y(l) = \frac{-qU l^2}{2mdv_0^2}$$

$$IH = \frac{l}{2}$$

$$\hookrightarrow \tan \alpha = \frac{-qU l^2}{mdv_0^2}$$

$$\Rightarrow \alpha = \tan^{-1} \left(\frac{-qU l^2}{mdv_0^2} \right)$$

3. Déterminons v_0 :

$$\tan \alpha = \frac{y_0}{D} \Rightarrow y_0 = D \tan \alpha$$

$$\Rightarrow y_0 = D \cdot \left(\frac{-qU l^2}{mdv_0^2} \right)$$

$$\hookrightarrow y_0 = \frac{-qU l^2}{mdv_0^2}$$

4.1. Calcule le y_0 pour l'électron:

$$y_0 = \frac{-(-1.6 \cdot 10^{-19}) \times 2 \cdot 10^4 \times 0.2 \times 1}{9.11 \cdot 10^{-31} \times 0.1 \times (2.5 \cdot 10^8)^2}$$

$$y_0 = 0.112 \text{ m.}$$

4.2. Calcul de m' :

$$y_0 = \frac{-2eU l^2}{m' d v_0^2} \text{ car } q = +2e$$

$$\Rightarrow m' = \frac{-2eU l^2}{y_0 d v_0^2}$$

$$\text{AN: } m' = \frac{-2 \times 1.6 \cdot 10^{-19} \times 2 \cdot 10^4 \times 0.2 \times 1}{-0.019 \times 0.1 \times (10^8)^2}$$

$$m' = 6.74 \times 10^{-27} \text{ kg.}$$

Nombre de masse:

$$m' = A \times m_n \Rightarrow A = \frac{m'}{m_n}$$

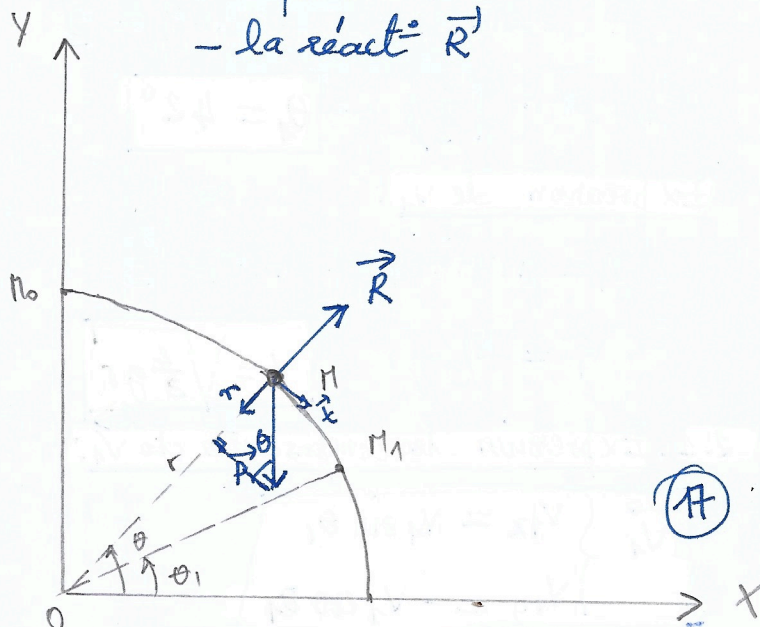
$$\text{AN: } A = \frac{6.74 \cdot 10^{-27}}{1.67 \cdot 10^{-27}} = 4$$

$$A = 4$$

Exercice 17:

1.1. Bilan des forces appliquées

- le poids $\vec{P}$
- la réaction $\vec{R}$



(17)

1.2. Expression de R

$$\text{TCI: } \vec{P} + \vec{R} = m\vec{a}$$

Suivant la normale :

$$mg \sin \theta - R = m a_n = m \cdot \frac{v^2}{r}$$

$$\Rightarrow \boxed{R = m \left(g \sin \theta - \frac{v^2}{r} \right)}$$

1.3. Expression de v:

TEC entre M_0 et M :

$$E_c(M) - E_c(M_0) = W(\vec{P}) + W(\vec{R})$$

$$\Rightarrow \frac{1}{2} m v^2 = mgh \text{ or } h = r(1 - \sin \theta)$$

$$\frac{1}{2} m v^2 = mgr(1 - \sin \theta)$$

$$\Rightarrow \boxed{v = \sqrt{2gr(1 - \sin \theta)}}$$

1.4. Valeur de θ_1

Si le mobile quitte la piste en M_1
 $R = 0$ et $\theta = \theta_1$

$$\hookrightarrow m \left(g \sin \theta_1 - \frac{v_1^2}{r} \right) = 0 \Rightarrow$$

$$v_1^2 = gr \sin \theta_1 = 2gr(1 - \sin \theta_1)$$

$$\Rightarrow \sin \theta_1 = 2(1 - \sin \theta_1)$$

$$\Rightarrow \sin \theta_1 = 2 - 2 \sin \theta_1$$

$$\Rightarrow 3 \sin \theta_1 = 2 \Rightarrow \sin \theta_1 = \frac{2}{3}$$

$$\theta_1 = \sin^{-1} \left(\frac{2}{3} \right) \Rightarrow \boxed{\theta_1 = 42^\circ}$$

Expression de v_1 :

$$v_1^2 = gr \sin \theta_1 \text{ or } \sin \theta_1 = \frac{2}{3}$$

$$\Rightarrow v_1^2 = \frac{2}{3} gr \Rightarrow \boxed{v_1 = \sqrt{\frac{2}{3} gr}}$$

2.1. Expression des composantes de $\vec{v}_1$:

$$\vec{v}_1 \begin{cases} v_{1x} = v_1 \sin \theta_1 \\ v_{1y} = -v_1 \cos \theta_1 \end{cases}$$

2.2. Equations horaires:

$$\text{TCI: } \vec{P} = m\vec{a} \Leftrightarrow m\vec{g} = m\vec{a}$$

$$\Rightarrow \vec{a} = \vec{g} \Rightarrow \vec{a} \begin{cases} a_x = 0 \\ a_y = -g \end{cases}$$

$$\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \vec{v} \begin{cases} v_x = v_1 \sin \theta_1 \\ v_y = -gt - v_1 \cos \theta_1 \end{cases}$$

$$\vec{v} = \frac{d\vec{on}}{dt} \Rightarrow \vec{on} \begin{cases} x = (v_1 \sin \theta_1)t + C_3 \\ y = -\frac{1}{2}gt^2 - (v_1 \cos \theta_1)t + C_4 \end{cases}$$

$$\text{A } t=0; \vec{OM}_1 \begin{cases} x_1 = C_3 = r \cos \theta_1 \\ y_1 = C_4 = r \sin \theta_1 \end{cases}$$

$$\Rightarrow \vec{on} \begin{cases} x = (v_1 \sin \theta_1)t + r \cos \theta_1 \\ y = -\frac{1}{2}gt^2 - (v_1 \cos \theta_1)t + r \sin \theta_1 \end{cases}$$

Equation de la trajectoire:

$$t = \frac{x - r \cos \theta_1}{v_1 \sin \theta_1}$$

$$\hookrightarrow y(x) = -\frac{g}{2} \left(\frac{x - r \cos \theta_1}{v_1 \sin \theta_1} \right)^2 - v_1 \cos \theta_1 \times \left(\frac{x - r \cos \theta_1}{v_1 \sin \theta_1} \right) + r \sin \theta_1$$

$$\Rightarrow \boxed{y(x) = -\frac{g(x - r \cos \theta_1)^2}{2v_1^2 \sin^2 \theta_1} - \frac{(x - r \cos \theta_1)}{\tan \theta_1} + r \sin \theta_1}$$

2.3. Expression de OH

Au point H $y = 0$:

$$\hookrightarrow -\frac{g(x - r \cos \theta_1)^2}{2v_1^2 \sin^2 \theta_1} - \frac{x - r \cos \theta_1}{\tan \theta_1} + r \sin \theta_1 = 0$$

Posons $x - r \cos \theta_1 = X$

$$\hookrightarrow -\frac{g}{2v_1^2 \sin^2 \theta_1} X^2 - \frac{X}{\tan \theta_1} + r \sin \theta_1 = 0$$

$$\Delta = \frac{1}{\tan^2 \theta_1} + \frac{4}{2V_1^2 \sin \theta_1}$$

$$= \frac{1}{\tan^2 \theta_1} + \frac{2gr}{\frac{2}{3}gr \sin \theta_1}$$

$$= \frac{1}{\tan^2 \theta_1} + \frac{3}{\sin \theta_1}$$

$$\Delta = \frac{1}{\tan^2 \theta_1} + \frac{9}{2}$$

$$X_1 = \frac{\frac{1}{\tan \theta_1} - \sqrt{\Delta}}{\frac{-g}{V_1^2 \sin^2 \theta_1}} > 0$$

L'autre solut² est négative.

$$X_1 = \frac{V_1^2 \sin^2 \theta_1 (\sqrt{\Delta} + \frac{1}{\tan \theta_1})}{g}$$

$$= \frac{\frac{2}{3}gr \cdot \frac{4}{3} (\sqrt{\Delta} - \frac{1}{\tan \theta_1})}{g}$$

$$= \frac{8}{27}r (\sqrt{\Delta} - \frac{1}{\tan \theta_1}) = 0,379r$$

$$x X_1 = x - r \sin \theta_1 \Rightarrow$$

$$x = X_1 + r \sin \theta_1$$

$$\Rightarrow x = 0,379r + r \sin \theta_1 = 1,12r$$

$$\text{Donc } OH = 1,12r$$

Exercice 19:

1. Equations horaires

Système: Projectile

Ref: TSG

$$\text{BFA: } \vec{P} = m\vec{g}$$

$$\text{TCI: } \vec{P} = m\vec{a} \Rightarrow \vec{a} = \vec{g}$$

$$\hookrightarrow \vec{a} \begin{cases} a_x = 0 \\ a_y = -g \end{cases} \Rightarrow \vec{v} \begin{cases} v_x = v_0 \cos \alpha \\ v_y = -gt + v_0 \sin \alpha \end{cases}$$

$$\Rightarrow \vec{OG} \begin{cases} x = (v_0 \cos \alpha)t \\ y = -\frac{1}{2}gt^2 + (v_0 \sin \alpha)t + h \end{cases}$$

2. Equation de la trajectoire:

$$y = -\frac{g}{2v_0^2 \cos^2 \alpha} x^2 + (\tan \alpha)x + h$$

3. Le projectile passe au dessus du mur si: $x = L$ et $y > H$

$$\hookrightarrow -\frac{gL^2}{2v_0^2 \cos^2 \alpha} + (\tan \alpha)L + h = H$$

$$-\frac{gL^2}{2v_0^2} (1 + \tan^2 \alpha) + (\tan \alpha)L + h - H = 0$$

$$-1,225(1 + \tan^2 \alpha) + L \tan \alpha - 4 = 0$$

$$\Delta \Rightarrow -1,225 \tan^2 \alpha + 8 \tan \alpha - 5,225 = 0$$

$$\Delta = 8^2 - 4 \times 1,225 \times 5,225$$

$$\Delta = 38,4$$

$$\tan \alpha_1 = \frac{-8 + \sqrt{38,4}}{2(-1,225)} = 0,74$$

$$\tan \alpha_2 = \frac{-8 - \sqrt{38,4}}{2(-1,225)} = 5,79$$

$$\Rightarrow \alpha_1 = 36,5^\circ \text{ et } \alpha_2 = 80,2^\circ$$

$$\text{Donc } 36,5^\circ \leq \alpha \leq 80,2^\circ$$

4.1. Calcul de la distance:

Si le projectile pas au point B:

$$x = L \Rightarrow y_B = y(L)$$

$$y_B = -\frac{gL^2}{2v_0^2 \cos^2 \alpha} + (\tan \alpha)L + h$$

$$y_B = 6,55 \text{ m}$$

$$d = y_B - H = 6,55 - 5$$

$$d = 1,55 \text{ m}$$

4.1. L'altitude maximale:

Au point le plus haut $v_y = 0$

$$\rightarrow -gt_s + v_0 \sin \alpha = 0$$

$$t_s = \frac{v_0 \sin \alpha}{g} = 1,15 \text{ s.}$$

$$y_s = -\frac{9,8}{2}(1,15)^2 + 16 \times \sin 45^\circ \times 1,15 + 4$$

$$y_s = 7,53 \text{ m.}$$

4.2. Calcul de β :

Au point B: $x = L \Rightarrow L = (v_0 \cos \alpha) t_B$

$$\Rightarrow t_B = \frac{L}{v_0 \cos \alpha} = \frac{8}{16 \times \cos 45^\circ} = 0,71 \text{ s}$$

$$\vec{v}_B \begin{cases} v_{Bx} = v_0 \cos \alpha \\ v_{By} = -gt_B + v_0 \sin \alpha \end{cases}$$

$$\vec{v}_B \begin{cases} v_{Bx} = 8\sqrt{2} \text{ m/s} \\ v_{By} = 4,36 \text{ m/s} \end{cases}$$

$$\tan \beta = \frac{v_{By}}{v_{Bx}} = \frac{4,36}{8\sqrt{2}} = 0,39$$

$$\beta = \tan^{-1}(0,39) = 21,3^\circ$$

Exercice 20:

1.1. Bilan des forces sur AB:

- le poids $\vec{P}$
- la réaction $\vec{R}$

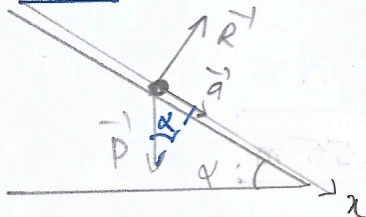
1.2. Valeur de l'accélération:

$$\text{TCI: } \vec{P}' + \vec{R}' = m\vec{a}$$

Suivant x

$$P \sin \alpha - 0 = ma$$

$$\Rightarrow a = g \sin \alpha$$



1.3. Expression de v_B :

TEC entre A et B:

$$\frac{1}{2} m v_B^2 = mgh \text{ or } h = L \sin \alpha$$

$$\Rightarrow \frac{1}{2} m v_B^2 = mgL \sin \alpha$$

$$\Rightarrow v_B = \sqrt{2gL \sin \alpha}$$

$$\text{AN: } v_B = \sqrt{2 \times 9,8 \times 3 \times \sin 45^\circ}$$

$$v_B = 6,45 \text{ m/s.}$$

2.1. Calcul de v_F :

TEC entre B et F:

$$\frac{1}{2} m (v_F^2 - v_B^2) = W(\vec{P}) + W(\vec{R})$$

$$\frac{1}{2} m (v_F^2 - v_B^2) = mgh$$

$$\text{or } h = r(1 - \cos \alpha)$$

$$\Rightarrow \frac{1}{2} m (v_F^2 - v_B^2) = mgr(1 - \cos \alpha)$$

$$\Rightarrow v_F = \sqrt{v_B^2 + 2gr(1 - \cos \alpha)}$$

$$\text{AN: } v_F = \sqrt{(5,3)^2 + 2 \times 9,8 \times 1,5(1 - \cos 45^\circ)}$$

$$v_F = 6,1 \text{ m/s.}$$

2.2. Mg $v_B = v_C$:

Entre les points B et C $h = 0$

$$\Rightarrow \frac{1}{2} m v_C^2 - \frac{1}{2} m v_B^2 = 0$$

$$\hookrightarrow v_C = v_B = 5,3 \text{ m/s}$$

2.3. Exprimons la réaction R :

$$\text{TEC: } \vec{P}' + \vec{R}' = m\vec{a}$$

$$R - P \sin \alpha = ma$$

$$\Rightarrow R = mg \sin \alpha + m \frac{v_B^2}{r}$$

$$R = m \left(g \sin \alpha + \frac{v_B^2}{r} \right)$$

$$\text{AN: } R = 0,25 \left(9,8 \times \sin 45^\circ + \frac{(5,3)^2}{1,5} \right)$$

$$R = 6,41 \text{ N.}$$

3.1. Equations horaires:

$$\vec{GC} \begin{cases} x = (v_c \cos \alpha) t \\ y = -\frac{1}{2} g t^2 + (v_c \sin \alpha) t \end{cases}$$

3.2. Equation de la trajectoire:

$$y(x) = -\frac{g}{2v_c^2 \cos^2 \alpha} x^2 + (\tan \alpha) x$$

$$\text{AN: } y = -0,349 x^2 + x$$

3.3. Coordonnées du point D:

$$\text{Au point D: } y_D = -r(1 - \cos \alpha)$$

$$\Rightarrow -0,349 x^2 + x + r(1 - \cos \alpha) = 0$$

$$\Rightarrow -0,349 x^2 + x + 0,44 = 0$$

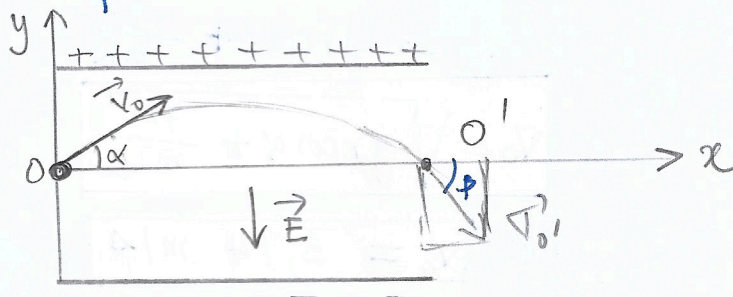
$$\Delta = 1 + 4 \times 0,349 \times 0,44 = 1,61$$

$$x_D = \frac{-1 - \sqrt{1,61}}{2(-0,349)} = 3,25 \text{ m}$$

$$x_D = 3,25 \text{ m et } y_D = -0,44 \text{ m}$$

Exercice 21:

1. Equation horaires:



système : Particule

Ref : TSG

$$\text{BFA: } \vec{F}_e = 2e \vec{E}$$

$$\text{TCI: } \vec{F}_e = m \vec{a}' \Rightarrow \vec{a}' = \frac{2e \vec{E}}{m}$$

$$\vec{a}' \begin{cases} a_x = 0 \\ a_y = -\frac{2eE}{m} \end{cases}$$

$$\Rightarrow \vec{v} \begin{cases} v_x = v_0 \cos \alpha \\ v_y = -\frac{2eE}{m} t + v_0 \sin \alpha \end{cases}$$

$$\Rightarrow \vec{OG} \begin{cases} x = (v_0 \cos \alpha) t \\ y = -\frac{eE}{m} t^2 + (v_0 \sin \alpha) t \end{cases}$$

2. Equation de la trajectoire:

$$y(x) = -\frac{eE}{mv_0^2 \cos^2 \alpha} x^2 + (\tan \alpha) x$$

$$E = \frac{U}{d}$$

$$\hookrightarrow y = -\frac{eU}{mdv_0^2 \cos^2 \alpha} x^2 + (\tan \alpha) x$$

$$y(x) = -3,10^{-3} U x^2 + x$$

3. Condition d'émergence:

$$x = L \text{ et } y < \frac{d}{2}$$

$$\hookrightarrow y(L) < \frac{d}{2}$$

$$\Rightarrow -3,10^{-3} U L^2 + L < \frac{d}{2}$$

$$\Rightarrow -3,10^{-3} U L^2 < \frac{d}{2} - L$$

$$\Rightarrow U > \frac{L - d/2}{3,10^{-3} L^2}$$

$$U > 2000 \text{ V}$$

4. Au point O' : $x=L$ et $y=0$

$$\Rightarrow y(L)=0$$

$$\Rightarrow -3 \cdot 10^{-3} u'^2 + L = 0$$

$$\Rightarrow u' = \frac{1}{3 \cdot 10^{-3} L} = \frac{0,10}{3 \cdot 10^{-3} \times 0,10}$$

$$u' = 3333 \text{ V}$$

Coordonnées de $\vec{V}_{O'}$:

Au point O' $x=L$

$$\Rightarrow L = (V_0 \cos \alpha) t' \Rightarrow t' = \frac{L}{V_0 \cos \alpha}$$

$$t' = \frac{0,1}{448 \cdot 10^3 \times \cos 45} = 3,15 \cdot 10^{-7} \text{ s}$$

$$\vec{v}_{O'} \begin{cases} v_{O'x} = V_0 \cos \alpha \\ v_{O'y} = \frac{-2q\epsilon t'}{md} + V_0 \sin \alpha \end{cases}$$

$$\vec{v}_{O'} \begin{cases} v_{O'x} = 3,17 \cdot 10^5 \text{ m/s} \\ v_{O'y} = -6,32 \times 10^5 \text{ m/s} \end{cases}$$

$$\|\vec{v}_{O'}\| = \sqrt{(-6,32 \cdot 10^5)^2 + (3,17 \cdot 10^5)^2}$$

$$\|\vec{v}_{O'}\| = 7,11 \cdot 10^5 \text{ m/s}$$

$$\tan \beta = \left| \frac{v_{O'y}}{v_{O'x}} \right| = 2$$

$$\beta = 63^\circ$$

Exercice 22:

1. Expression de V_M :

$$\text{TEC: } \frac{1}{2} m (V_M^2 - V_A^2) = mgh$$

$$\Rightarrow V_M = \sqrt{V_A^2 + 2gr \sin \beta}$$

$$\text{AN: } V_A = 5,1 \text{ m/s}$$

1.2. Valeur de V_B :

$$\text{Au point B: } \beta = \frac{\pi}{2} \Rightarrow$$

$$\sin \beta = 1$$

$$\Rightarrow V_B = \sqrt{V_A^2 + 2gr}$$

$$\text{AN: } V_B = 6 \text{ m/s}$$

2.3. La vitesse v_c du solide

Le tronçon BC est parfaitement lisse de plus P' ne travaille pas donc le mouvement est rectiligne uniforme

$$v_c = v_B = 6 \text{ m/s}$$

2.4. Le principe d'inertie:

Dans un référentiel galiléen, si un système est soumis à un ensemble de forces qui se compensent alors il est animé d'un mouvement rectiligne uniforme.

3.1. TCI: $\vec{P} + \vec{R} = m\vec{a}$

suivant la normale:

$$-P \cos \alpha + R_n = m a_n$$

$$\Rightarrow m a_n = mg \cos(\alpha) + R_n$$

$$\Rightarrow \frac{V_0^2}{r} = g \cos \alpha + \frac{R_n}{m}$$

$$\text{or } K = \frac{f}{R_n} \Rightarrow R_n = \frac{f}{K}$$

$$\Rightarrow V_0^2 = g r \cos \alpha + \frac{f r}{m K}$$

$$\Rightarrow V_0 = \sqrt{g r \cos \alpha + \frac{f r}{m K}}$$

$$\text{AN: } V_0 = 3,74 \text{ m/s}$$