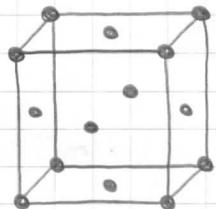


Chimie :

1) a)



$$b) Z = 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$$

c) 12

d) tangente sur la diagonale d'une face  $\Rightarrow 4R = a\sqrt{2}$ 

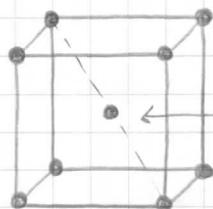
$$R = \frac{a\sqrt{2}}{4} = 198 \text{ pm}$$

$$\rho = \frac{Z \times M}{N_A V} = \frac{4 \times 40}{6,02 \times 10^{23} \times (559 \times 10^{-12})^3}$$

$$e) \rho = \frac{4 \times \frac{4}{3} \pi R^3}{a^3}$$

$$\rho = \frac{16 \pi R^3}{3 \times a^3} = \frac{\pi \sqrt{2}^3}{6} \approx 74\%$$

2) a)



$$4R = a\sqrt{3} \Rightarrow a = \frac{4R}{\sqrt{3}} = 457 \text{ pm}$$

b) modèle des sphères deux tangentes non vérifié

$$c) \rho = \frac{Z \times M}{N_A V} \quad \Delta Z=2 \quad \Rightarrow \rho = 1,68 \times 10^6 \text{ g/m}^3$$

Mécanique :

Exercice n°1 :

1) a) RFD appliquée au point M dans le référentiel terrestre suppose galiléen :

$$m\vec{a} = m\vec{g} \quad \vec{a} = \vec{g} \quad \text{selon } Oy : \dot{y} = 0$$

$\ddot{y} = Ct = 0$   $\Rightarrow$  H0 uniforme  
 $= v_0 \cos \alpha$

b)  $t_s$  est telle que  $\dot{y} = 0$ 

$$\ddot{y} = -g \Rightarrow \dot{y} = -gt + \underline{v_0 \sin \alpha} \quad t_s = \frac{v_0 \sin \alpha}{g}$$

$$c) y = (v_0 \cos \alpha) t \quad (y(0) = 0) \Rightarrow y_s = v_0 \cos \alpha \times \frac{v_0 \sin \alpha}{g} = \frac{v_0^2 \cos \alpha \sin \alpha}{g}$$

$$y_s = \frac{v_0^2 \sin 2\alpha}{2g}$$

d) la variation d' $E_c$  dans 1 référentiel galiléen entre 2 points A et B est égale à la somme des travaux des forces appliquées entre A et B.

$$E_c(B) - E_c(A) = \sum_{A \rightarrow B} \Delta E$$

e) point à  $t=0$  : A sommet : S

$$\frac{1}{2}mv_s^2 - \frac{1}{2}mv_A^2 = \Delta E (m\ddot{g}) = -mg(3s - H)$$

$$\left. \begin{array}{l} v_s = v_0 \cos \alpha \\ v_A = v_0 \end{array} \right\} \Rightarrow z_s = H + \frac{v_0^2 - v_0^2 \cos^2 \alpha}{2g} = H + \frac{v_0^2 \sin^2 \alpha}{2g}$$

1)  $\dot{z} = -gt + v_0 \sin \alpha \Rightarrow z = -\frac{gt^2}{2} + (v_0 \sin \alpha) t + H \quad (z(0) = H)$

$$z_s = z(t_s) = -\frac{g}{2} \frac{(v_0 \sin \alpha)^2}{g^2} + \frac{(v_0 \sin \alpha)^2}{g} + H = H + \frac{(v_0 \sin \alpha)^2}{g} \quad \text{QED.}$$

g) AN:  $t_s = 0,5s \quad y_s = 4,33m \quad z_s = 3,25m$

2) a)  $\ddot{z}(y) = -\frac{gy^2}{2(v_0 \cos \alpha)^2} + \tan \alpha y + H$

$$\text{au rd } \dot{z}=0 \Rightarrow \frac{-g}{2v_0^2 \cos^2 \alpha} y_c^2 + \tan \alpha y_c + H = 0$$

$$y_c^2 - \frac{2v_0^2 \cos^2 \alpha \tan \alpha y_c}{g} - \frac{2v_0^2 \cos^2 \alpha H}{g} = 0$$

$$\Leftrightarrow y_c^2 - \frac{v_0^2}{g} \sin(2\alpha) y_c - \frac{2v_0^2 H \cos^2 \alpha}{g} = 0$$

b)  $2y_c \frac{dy_c}{dx} - \frac{v_0^2}{g} (2 \cos(2\alpha) y_c + \sin(2\alpha) \frac{dy_c}{dx}) + \frac{2v_0^2 H}{g} 2 \cos \alpha \sin \alpha = 0$

$$\frac{dy_c}{dx} = \frac{\frac{v_0^2}{g} \cos(2\alpha) y_c - \frac{2v_0^2 H \sin(2\alpha)}{g}}{2y_c - \frac{v_0^2}{g} \sin(2\alpha)} \frac{dy_c}{dx} = 0 \Leftrightarrow y_{cm} = A \tan(2\alpha) = H \frac{2 \tan \alpha}{1 - \tan^2 \alpha}$$

on pose  $u = \tan \alpha$

$$\cos^2 \alpha = \frac{1}{1+u^2} \Leftrightarrow \frac{-2gH^2}{v_0^2} (1+u^2) \frac{u^2}{(1-u^2)^2} + \frac{2Hu^2}{1-u^2} + H = 0 \Leftrightarrow \frac{-2gH^2}{v_0^2} (1+u^2) \frac{u^2}{(1-u^2)^2} + \frac{H(1+u^2)}{1-u^2} = 0$$

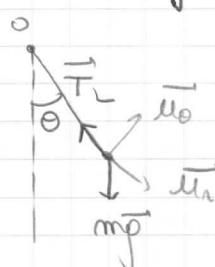
$$\Leftrightarrow \frac{2gH}{v_0^2} \frac{u^2}{1-u^2} = 1 \quad \text{et } u^2 = 1 - \frac{1}{1+u^2}$$

$$u^2 = \tan^2 \alpha = \frac{1}{1 + \frac{2gH}{v_0^2}}$$

(d)  $\tan^2 \alpha_m = \frac{1}{1+uH} \Rightarrow y_{cm} = \frac{2H}{(1+uH)(1-\frac{1}{1+uH})} = \frac{2H}{1+uH} - \frac{1}{1+uH} = \frac{2H \sqrt{1+uH}}{uH} = \frac{v_0^2}{g} \sqrt{1+2g \frac{H}{v_0^2}} \approx 12m$

## Exercice n°2.

1)  $\vec{m}\ddot{\alpha} = \vec{m\ddot{g}} + \vec{T}$  selon  $\vec{u}_0$ :  $mL\ddot{\theta} = -m\ddot{g} \sin\theta$

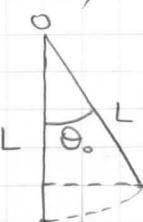


$$\Leftrightarrow L\ddot{\theta} + g \sin\theta = 0$$

2)  $\ddot{\theta} + \frac{g}{L} \theta = 0$  oscillation harmonique non amortie  
 $\Rightarrow$  pulsation  $\omega_0 = \sqrt{\frac{g}{L}}$   $\Rightarrow$  période  $T = 2\pi \sqrt{\frac{L}{g}}$

durée de la 1<sup>ère</sup> phase  $T_I = \frac{T}{4} = \frac{\pi}{2} \sqrt{\frac{L}{g}}$

3)  $\frac{1}{2}m\dot{v}^2(t_i^-) - \frac{1}{2}m\dot{v}^2(0) = \cancel{V}/(\vec{m\ddot{g}})$   $\vec{T} \perp$  au déplacement donc ne travaille pas

  
 $\Rightarrow v(t_i^-) = \sqrt{2gL(1-\cos\theta_0)}$   $\Rightarrow \omega(t_i^-) = \frac{\sqrt{2gL(1-\cos\theta_0)}}{L}$   
 (en valeur absolue) (v selon -\vec{u}\_0)

4)  $v(t_i^+) = v(t_i^-) = \sqrt{2gL(1-\cos\theta_0)} \Rightarrow \omega(t_i^+) = \frac{\sqrt{2gL(1-\cos\theta_0)}}{2L}$   
 (en valeur absolue)

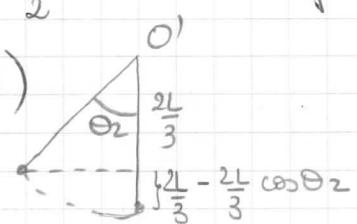
5)  $T_I = \frac{\pi}{2} \sqrt{\frac{2L}{3g}}$

6) à la date  $t_2$ :  $v(t_2) = 0$

TEC entre la verticale ( $\theta=0$ ) et  $\theta_2$ :  $\frac{1}{2}m\dot{v}^2(t_2) - \frac{1}{2}m\dot{v}^2(t_1) = \cancel{V}/(\vec{m\ddot{g}})$

$$-\frac{1}{2}m\ddot{v} \times \frac{2L}{3}K(1-\cos\theta_0) = -\cancel{m\ddot{v}} \left( \frac{2L}{3}(1-\cos\theta_2) - 0 \right)$$

$$\cos\theta_2 = \frac{3\cos\theta_0 - 1}{2}$$



7) 1<sup>ère</sup> phase + 2<sup>ème</sup> phase =  $\frac{1}{2}$  oscillation (le mo<sup>r</sup> se reproduit dans l'autre sens etc...)

$$\Rightarrow T = (T_I + T_{II}) \times 2 = \pi \sqrt{\frac{L}{g}} \left( 1 + \sqrt{\frac{2}{3}} \right)$$