-1- $\vec{R} \perp \vec{V}$ car sans frottement $\Rightarrow \mathcal{P}_R(\vec{R}) = 0$ (0,5)

-2- $E_p(\vec{P}) = -\int \vec{P}.\vec{d\ell} = +mgz + \beta$ (0,5) , $\alpha = mg$ (0,5)

-3- a- E_m se conserve sur le trajet AB car $\vec{P}$ conservative et $\vec{R}$ ne travaille pas (0,5)

b- $E_m = E_K(M/R) + E_p(\vec{P}) = \frac{1}{2}mV^2 + mgz + \beta$ (0,5) (0,5)

c- E_m = cste entre A et B $\Rightarrow \frac{1}{2}m\underbrace{V_A^2}_{=0} + mg\underbrace{z_A}_{=h} + \cancel{\beta} = \frac{1}{2}mV_B^2 + mg\underbrace{z_B}_{=0} + \cancel{\beta}$ (0,5)

$\Rightarrow V_B = \sqrt{2gh}$ (0,5)

d- $\vec{V_B} = \vec{V}(M/R)/_{M=B} = V_B\,\vec{e_x}$ (0,5)

-4- $\vec{O_1M} = a\,\vec{e_\rho} \Rightarrow \vec{V}(M/R) = a\dot{\varphi}\,\vec{e_\varphi}$ (1)

-5- a- $\vec{P} = m\vec{g} = mg\,\vec{e_{x_1}} = mg(\cos\varphi\,\vec{e_\rho} - \sin\varphi\,\vec{e_\varphi})$ (1)

b- $\mathcal{P}_R(\vec{P}) = \vec{P}.\vec{V}(M/R) = -mga\,\dot{\varphi}\sin\varphi$ (0,5) (0,5)

c- $E_p(\vec{P}) = -\int \mathcal{P}_R(\vec{P})\,dt = -mga\cos\varphi + C_2$ (0,5) (0,5)

-6- $\delta W(\vec{R}) = 0$ car $\vec{R} \perp \vec{d\ell}$ (0,5)

-7- a- $E_m(M/R)$ = cste car $\vec{P}$ conservative & $\vec{R}$ ne travaille pas. (0,5)

b- $E_m(M/R) = \frac{1}{2}ma^2\dot{\varphi}^2 - mga\cos\varphi + C_2$ (0,5)

c- $\frac{dE_m(M/R)}{dt} = \underbrace{\mathcal{P}_R(\vec{F}_{NC})}_{=0}$ (0,5) $\Rightarrow ma^2\dot{\varphi}\ddot{\varphi} + mga\dot{\varphi}\sin\varphi = 0$ $\Rightarrow \ddot{\varphi} + \frac{g}{a}\sin\varphi = 0$ (0,5)

d- * $\varphi \ll 1 \Rightarrow \sin\varphi \sim \varphi \Rightarrow \ddot{\varphi} + \frac{g}{a}\varphi = 0$ où $\omega = \sqrt{\frac{g}{a}}$ (0,5)

* $\Rightarrow \varphi_{(t)} = A\cos\omega t + B\sin\omega t$ (0,5)

$\left.\begin{cases} \varphi(t=0) = A = 0 & (0,5) \\ \dot{\varphi}(t=0) = B\omega = \dot{\varphi}_0 & (0,5) \end{cases}\right\} \Rightarrow \varphi_{(t)} = \frac{\dot{\varphi}_0}{\omega}\sin\omega t$

-8- a- $\vec{a}(M/R) = -a\dot{\varphi}^2\,\vec{e_\rho} + a\ddot{\varphi}\,\vec{e_\varphi}$ (1)

-9- a- $m\vec{a}(M/R) = \vec{P} + \vec{R} + \vec{F_V}$ (0,5)

b- $\vec{e_\rho}.\quad -ma\dot{\varphi}^2 = mg\cos\varphi - R \quad (1) \Rightarrow \dot{\varphi}^2 + \frac{g}{a}\cos\varphi = \frac{R}{ma}$ (0,5)

$\vec{e_\varphi}.\quad ma\ddot{\varphi} = -mg\sin\varphi - \mu_v a\dot{\varphi} \quad (2) \Rightarrow \ddot{\varphi} + \frac{\mu_v}{m}\dot{\varphi} + \frac{g}{a}\sin\varphi = 0$ (0,5)

où $\tau = 2\frac{m}{\mu_v}$ (0,5) $[\tau]$ = Temps (0,5)

-10- a- si $\tau > \frac{1}{\omega}$ alors le temps d'amortissement étant > à la période propre de l'oscillateur $T = \frac{2\pi}{\omega} \Rightarrow$ oscillat° possible. (0,5)

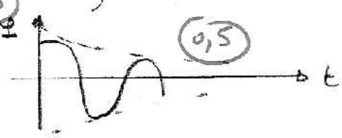
b- $\varphi_{(t)} = e^{-t/\tau}[A\cos\omega t + B\sin\omega t]$ (0,5)

$\varphi(t=0) = A = \varphi_0$ (0,5)

$\dot{\varphi}(t=0) = 0 = -\frac{A}{\tau} + B\omega$ (0,5)

$\Rightarrow \varphi_{(t)} = \varphi_0 e^{-t/\tau}\left[\cos\omega t + \frac{1}{\omega\tau}\sin\omega t\right]$

c- $T' = 2\pi/\sqrt{\omega^2 - 1/\tau^2}$ (0,5)



(0,5)

d- $\varphi_{(t)} \longrightarrow 0$ i.e en B (0,5)