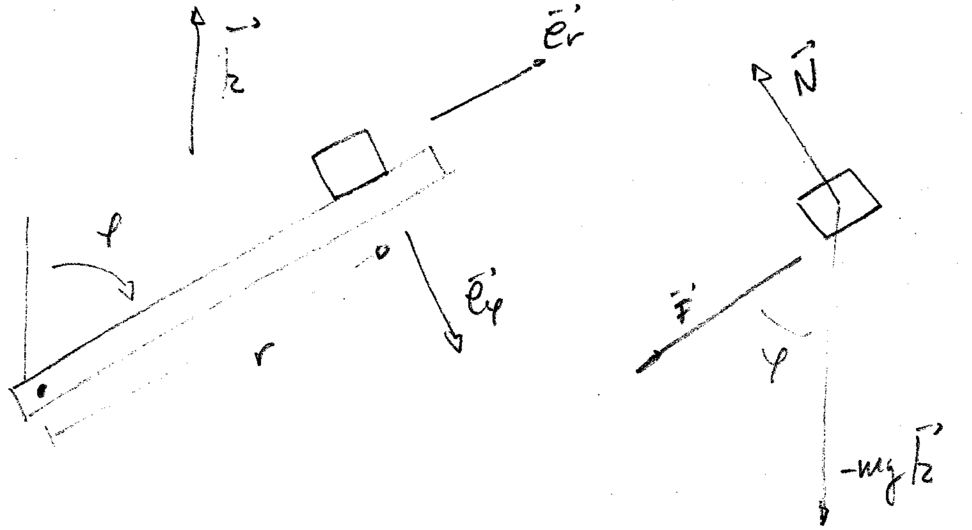
1



ⓐ

$$\vec{r} = r\vec{e_r} \qquad (\vec{e_r}) \quad -mr\dot{\varphi}^2 = -mg\cos\varphi - F$$

$$\vec{v} = r\dot{\varphi}\vec{e_\varphi} \qquad (\vec{e_\varphi}) \quad 0 = -N + mg\,\mathrm{sen}\varphi$$

$$\vec{a} = -r\dot{\varphi}^2\vec{e_r} \qquad (\dot{\varphi} = \omega)$$

$$|\vec{F}|_{max} = \mu_e|N| \qquad \begin{aligned} F &= mr\omega^2 - mg\cos\varphi \\ N &= mg\,\mathrm{sen}\varphi \end{aligned}$$

No deslizamiento $\Leftrightarrow$ $|F| < |\vec{F}|_{max}$

$$|mr\omega^2 - mg\cos\varphi| < \mu_e mg\,\mathrm{sen}\varphi \qquad (\varphi \in (0,\pi))$$

ⓑ

$$\vec{v} = \dot{r}\vec{e_r} + r\dot{\varphi}\vec{e_\varphi}$$

$$\vec{a} = \ddot{r}\vec{e_r} + 2\dot{r}\dot{\varphi}\vec{e_\varphi} - r\dot{\varphi}^2\vec{e_r}$$

$$\begin{cases} m(\ddot{r} - r\omega^2) = -mg\cos\varphi - F \\ 2m\dot{r}\omega = -N + mg\,\mathrm{sen}\varphi \end{cases}$$

Para no desprendimiento en instante inicial $N(t=0) \geq 0$

$$m(g\,\mathrm{sen}\varphi_0 - 2v_0\omega) \geq 0$$

$$\boxed{v_0 \leqslant \frac{g \operatorname{sen}\varphi_0}{2\omega}}$$

(c) Partícula deslizando $\Rightarrow$ $\vec{F} = f_d N \vec{e_r}$

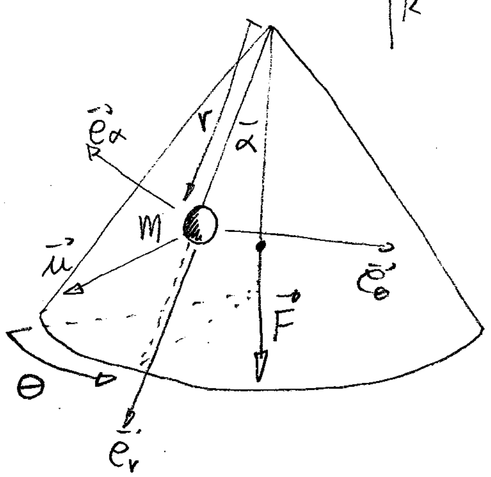
$v_0 < \emptyset$

$$\begin{cases} m(\ddot{r} - r\omega^2) = -mg\cos\varphi + f_d N \\ N = mg\operatorname{sen}\varphi - 2m\dot{r}\omega \end{cases}$$

$$m\ddot{r} - mr\omega^2 = -mg\cos\varphi + f_d\, mg\operatorname{sen}\varphi - 2f_d m\dot{r}\omega$$

$$\boxed{\ddot{r} + 2f_d\omega\,\dot{r} - \omega^2 r = g\left(f_d\operatorname{sen}\varphi - \cos\varphi\right)}$$

② (a) (III)



$$\vec r = r\vec e_r\,,\quad \vec v = \dot r\,\vec e_r + r\,\text{sen}\alpha\,\dot\theta\,\vec e_\theta$$

$$\vec a = \ddot r\,\vec e_r + 2\dot r\dot\theta\,\text{sen}\alpha\,\vec e_\theta +$$

$$\left(\dot{\vec e}_r = \dot\theta\,\vec k\times\vec e_r = \dot\theta\,\text{sen}\alpha\,\vec e_\theta\right)$$

$$+\ r\,\text{sen}\alpha\,\ddot\theta\,\vec e_\theta - r\,\text{sen}\alpha\,\dot\theta^2\,\vec u$$

$$\left(\dot{\vec e}_\theta = \dot\theta\,\vec k\times\vec e_\theta = -\dot\theta\,\vec u\right)$$

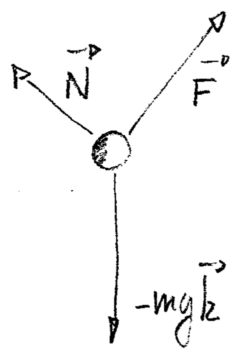
$$m\vec a\cdot\vec e_\theta = m\left(2\dot r\dot\theta\,\text{sen}\alpha + r\,\text{sen}\alpha\,\ddot\theta\right) = 0 \Rightarrow \quad 2\dot r\dot\theta + r\ddot\theta = 0$$

$$\frac{d}{dt}\left(r^2\dot\theta\right) = 2r\dot r\dot\theta + r^2\ddot\theta = 0 \Rightarrow$$

$$\boxed{\begin{aligned}\vec L_0 &= \vec r\times m\vec v = m r^2\,\text{sen}\alpha\,\dot\theta\,\vec e_\alpha\\ \vec L_0\cdot\vec k &= m r^2\,\text{sen}^2\alpha\,\dot\theta\end{aligned}}$$

$$r^2\dot\theta = c^{te}$$

(b)



$$\vec N\cdot\vec v = 0 \qquad \vec N \text{ no trabaja.}$$

$$\delta W = \vec F\cdot d\vec r = -F\,dr \Rightarrow \quad W = -F\Delta r \Rightarrow$$

$$W = -\Delta U \,/\, U = +Fr$$

$$E_{mec.} = c^{te} = \frac{1}{2}m\left(\dot r^2 + r^2\,\text{sen}^2\alpha\,\dot\theta^2\right) - mgr\cos\alpha + Fr$$

$$t=0\,;\quad \dot r = 0\,;\quad r\,\text{sen}\alpha\,\dot\theta = v \Rightarrow \quad r^2\,\text{sen}\alpha^2\,\dot\theta = r_0\,\text{sen}\alpha\,v_0$$

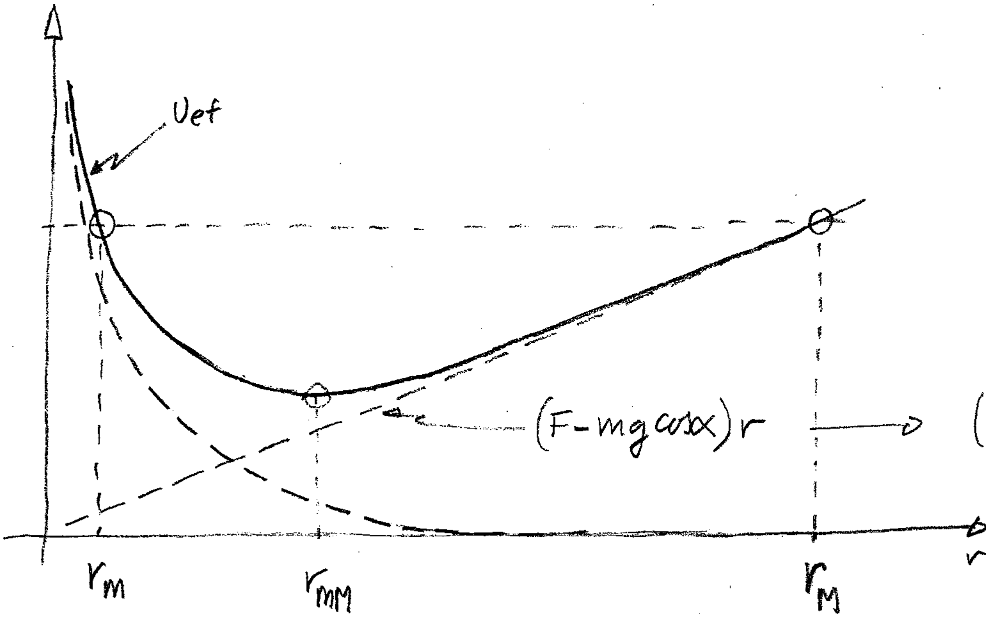
$$\dot\theta = \frac{r_0 v_0}{r^2\,\text{sen}\alpha}$$

$$\frac{m\dot r^2}{2} + \frac{m\cancel{r^2}\,\cancel{\text{sen}^2\alpha}}{2}\,\frac{(r_0v_0)^2}{r^{\cancel{4}\,2}\,\cancel{\text{sen}^2\alpha}} - mgr\cos\alpha + Fr = \underbrace{\frac{m\,\text{sen}^2\alpha\,v_0^2}{2} - mgr_0\cos\alpha + Fr_0}_{E_0}$$

$$\frac{m\dot r^2}{2} + \underbrace{\frac{m}{2}\cdot\frac{(r_0v_0)^2}{r^2} + (F - mg\cos\alpha)\,r}_{U_{ef}(r)} = E_0$$

$$\dot{r}^2 = \frac{2}{m}\left(E_0 - U_{ef}(r)\right)$$

c)



$\rightarrow (F - mg\cos\alpha) > 0$

$F > mg\cos\alpha$

d)

$$\frac{\partial U_{ef}}{\partial r} = 0 \quad \Rightarrow \quad -\frac{m\,(r_0 v_0)^2}{r^3} + (F - mg\cos\alpha) = 0.$$

$$r_{mM}^3 = r_0^3 = \frac{m\,(r_0 v_0)^2}{(F - mg\cos\alpha)}$$

$$\boxed{r_{mM} = \frac{m\,v_0^2}{(F - mg\cos\alpha)}}$$