*Universidad de Chile*
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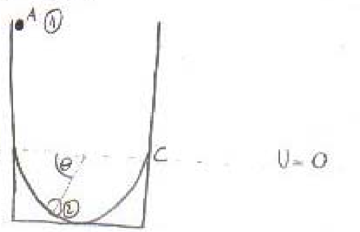
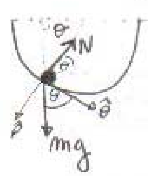
# SOLUCIÓN AUXILIAR 9

## P1.

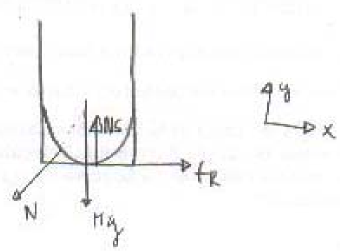
P1] Ex-2°-99




DCL bolita




DCL vaso




$\Sigma F \hat{\rho}$ $\quad -N + mg\,\mathrm{sen}\,\theta = m\underbrace{\frac{v^2}{R}}_{a_{cent}} = m\omega^2 R \quad$ (a)

$\Sigma F \hat{\theta}$ : $\quad mg\cos\theta = m\underbrace{R\ddot{\theta}}_{a_{tang}} \quad$ (b)

aplicamos ahora conservación de energía

En ① $\quad E_1 = mg(h-R)$

En ② $\quad E_2 = -mgR\cos\theta + \frac{1}{2}mv^2$

$E_1 = E_2$

$\cancel{m}g(h-R) = -\cancel{m}gR\cos\theta + \frac{1}{2}\cancel{m}v^2$

$g(h-R) + gR\cos\theta = \frac{v^2}{2} \quad \Rightarrow \quad v^2 = 2g[h-R+R\cos\theta]$

Luego la aceleración centrípeta es $a_{cent} = \frac{v^2}{R} = \frac{2g}{R}[h-R+R\cos\theta]$

de (b) se tiene la aceleración tangencial $\quad R\ddot{\theta} = g\cos\theta$

Para el vaso:

$\Sigma F_y \quad N_S - N\,\mathrm{sen}\,\theta - Mg = 0 \quad \Rightarrow \quad N_S = N\,\mathrm{sen}\,\theta + Mg$

de (a) $\quad N = mg\,\mathrm{sen}\,\theta - m\frac{v^2}{R}$

$\Sigma F_x$: $\quad f_R - N\cos\theta = 0 \quad \Rightarrow \quad f_R = N\cos\theta$

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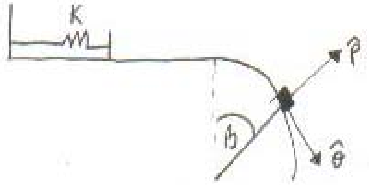
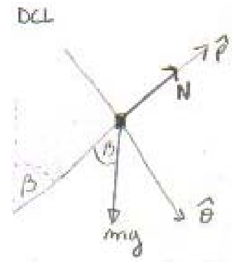
**P2.**

P1| EX - 2° - 2001




β es conocido

$\hat{\rho}$ : $\Sigma F_{\rho} = N - mg\cos\beta = -m\,a_{centrípeta} = -m\omega^2 R$ ①

$\hat{\theta}$ : $\Sigma F_{\theta} = mg\sin\beta = m\,a_{tangencial} = m\alpha = m\ddot{\theta}$ ②

De ① tenemos : $N = mg\cos\beta - m\omega^2 R$

Cuando se pierde contacto $N = 0$

$$\Rightarrow \cancel{m}g\cos\beta = \cancel{m}\omega^2 R \qquad \boxed{v = \omega R} \ ③$$

Ocupando ③

$$g\cos\beta = \frac{v^2}{R}$$

$$\Rightarrow v^2 = Rg\cos\beta \quad (*)$$

Ahora ocupamos energía :


$E_{①} = mgR + \frac{1}{2}K\Delta x^2$ $\qquad$ $\Delta x$ compresión del resorte

$E_{②} = mgR\cos\beta + \frac{1}{2}mv^2$ $\qquad$ $v^2$ calculado en (*)

$E_{②} = E_{①}$

$$mgR + \frac{1}{2}K\Delta x^2 = mgR\cos\beta + \frac{1}{2}mv^2$$

$$\frac{1}{2}K\Delta x^2 = \frac{1}{2}mv^2 + mgR\cos\beta - mgR$$

$$\frac{1}{2}K\Delta x^2 = \frac{1}{2}mv^2 + mgR\cos\beta - mgR$$

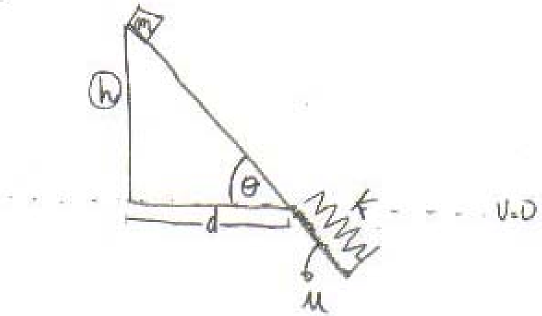
$$\frac{1}{2}K\Delta x^2 = \frac{1}{2}mRg\cos\beta + mgR\cos\beta - mgR = \frac{3}{2}mgR\cos\beta - mgR$$

$$\frac{1}{2}K\Delta x^2 = mgR\left(\frac{3}{2}\cos\beta - 1\right)$$

$$\Delta x^2 = \frac{2mgR}{K}\left(\frac{3}{2}\cos\beta - 1\right)$$

**P3.**

P]




$tg\theta = h/d$



$E_i = d\, tg\theta\, g\, m$

$E_f = \frac{1}{2} K \Delta X^2 - mg\, sen\theta\, \Delta X$

$E_f - E_i = \frac{1}{2} K \Delta X^2 - mg\, sen\theta\, \Delta X - d\, tg\theta\, g\, m = -\mu\, mg \cos\theta\, \Delta X$

$\frac{1}{2} K \Delta X^2 - mg\, sen\theta\, \Delta X + \mu\, mg \cos\theta\, \Delta X - d\, tg\theta\, g\, m = 0$

$\frac{1}{2} K \Delta X^2 + \Delta X(\mu\, mg \cos\theta - mg\, sen\theta) - d\, tg\theta\, g\, m = 0$

$$\Delta X = \frac{mg\, sen\theta - \mu\, mg \cos\theta \pm \sqrt{(\mu\, mg \cos\theta - mg\, sen\theta)^2 + 2K d\, tg\theta\, g m}}{2K}$$

$$\Delta X = \frac{mg\, sen\theta - \mu\, mg \cos\theta + \sqrt{(\mu\, mg \cos\theta - mg\, sen\theta)^2 + 2K d\, tg\theta\, g m}}{2K}.$$

**P4.**

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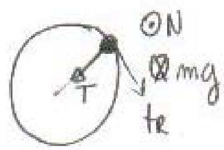
$E_f - E_i = W$

DCL




- La única fuerza que realiza trabajo es la fuerza de roce
- $E_i = \frac{1}{2} m v_0^2$

$E_f = \frac{1}{2} m \left(\frac{v_0}{2}\right)^2 = \frac{1}{2} m \frac{v_0^2}{4} = \frac{1}{8} m v_0^2$

$E_f - E_i = W \Rightarrow \frac{1}{8} m v_0^2 - \frac{1}{2} m v_0^2 = -\frac{3}{8} m v_0^2 = W_{roce}$

- $W = \int \vec{f} \cdot d\vec{r} \Rightarrow W = -\mu N \cdot 2\pi R = -\mu m g 2\pi R = -\frac{3}{8} \cancel{m} v_0^2$

$\Rightarrow \mu = \frac{3 v_0^2}{16 g \pi R}$

- $E_f - E_i = -\mu N 2\pi R \cdot n$ $n$ = nº de vueltas.

$E_f = 0$ cuando se detiene

$-\frac{1}{2} m v_0^2 = -\mu N 2\pi R \cdot n$

$-\frac{1}{2} \cancel{m} \cancel{v_0^2} = -\frac{3 \cancel{v_0^2}}{16 \cancel{g} \cancel{\pi R}} \cdot \cancel{m} \cancel{g}\, 2 \cancel{\pi R}\, n$

$\frac{4}{3} = n \Rightarrow$ da una vuelta y $\frac{1}{3}$ de vuelta