# Resum

$W_{FC} = -\Delta E_P$ *Treball de les forces conservatives*

$W_{FNC} = \Delta E_M$ *Treball de las forces no conservatives*

$W_{tot} = \Delta E_c$ *Treball de totes les forces*

$$W_{tot} = W_{FC} + \boxed{W_{FNC}} = -\Delta E_P + \boxed{\Delta E_M} = \Delta E_c$$

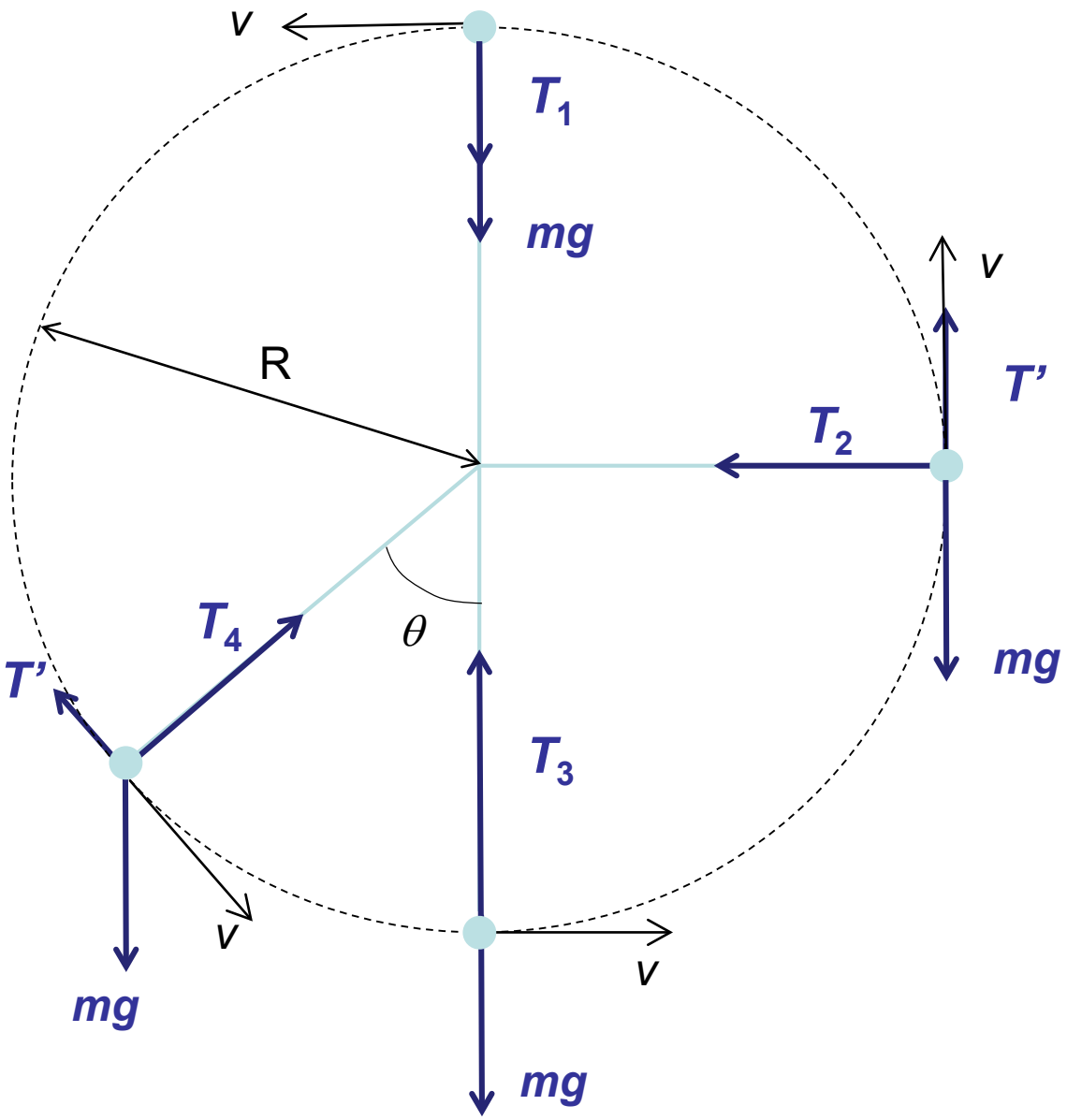
# Moviment circular

Si ω=*const*.

*L'energia cinètica és constant, però l'energia potencial va variant.*

Quina força fa el treball?

$$dW = \vec{F} \cdot d\vec{r}$$

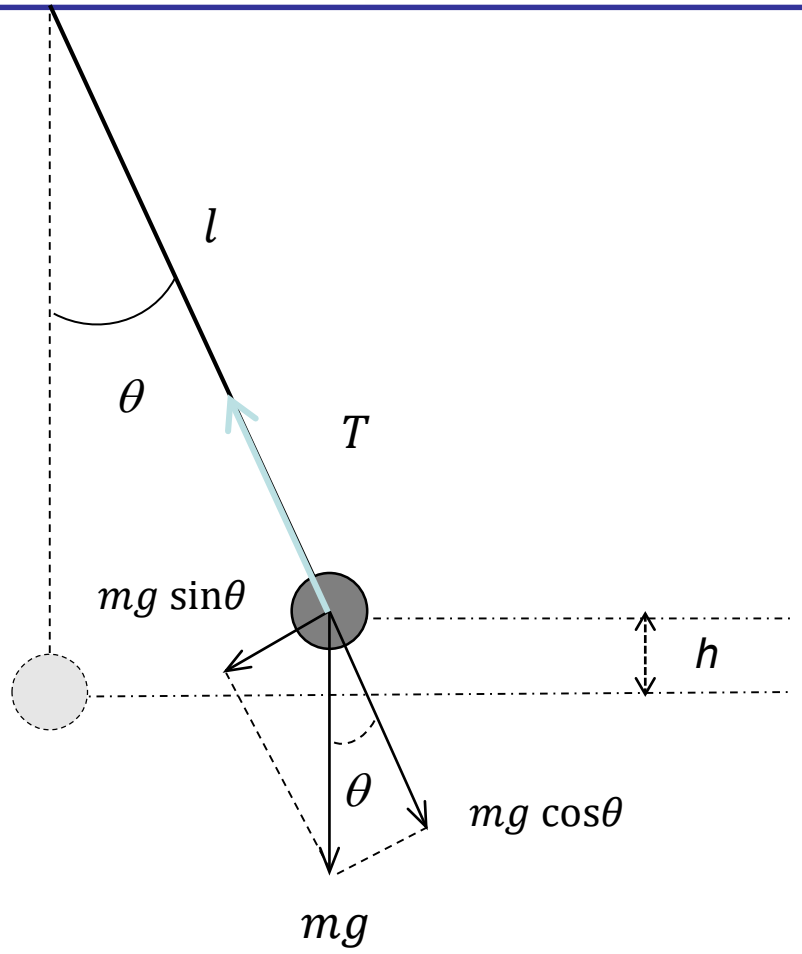


# *Pèndol simple

*Equacions del movimient*

$$T - mg\cos\theta = m\frac{v^2}{l} = ml\left(\frac{d\theta}{dt}\right)^2 \qquad [ds = ld\theta]$$

$$mg\sin\theta = -ma_t = -ml\frac{d^2\theta}{dt^2}$$




*Per angles petits* ($\theta$ <15º $\Rightarrow$ $\sin\theta \approx \theta$):

$$\theta = -\frac{l}{g}\frac{d^2\theta}{dt^2}$$

és un MHS amb periode

$$P = 2\pi\sqrt{\frac{l}{g}}$$

$$E_P = mgh = mgl(1-\cos\theta) \cong mgl\frac{\theta^2}{2}$$

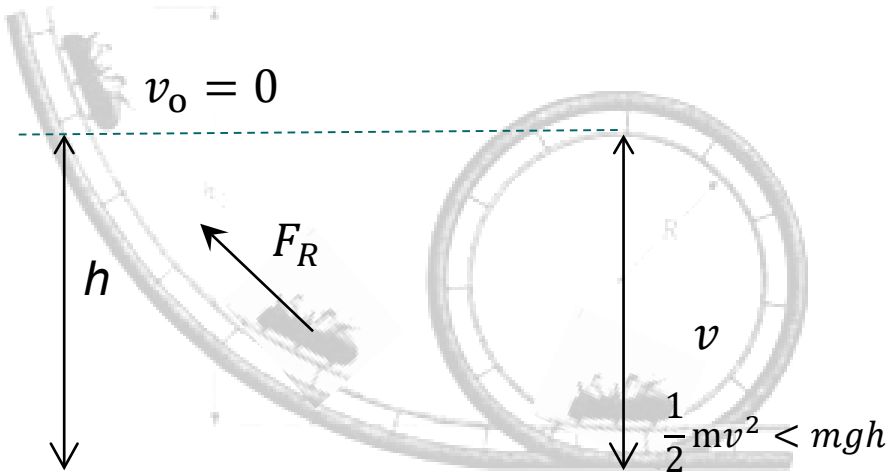
$$E_C = \frac{1}{2}m\omega^2 l^2 = \frac{1}{2}ml^2\left(\frac{d\theta}{dt}\right)^2$$

# Forces no conservatives: *Fregament*

No conserven l'energia **mecànica**: Introdueixen energia o la "perden" (per exemple, en forma de calor).

En general:

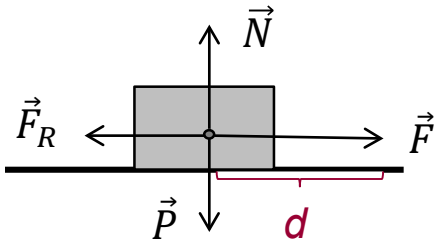
$$E_{mecànica}^{(inicial)} = E_{mecànica}^{(final)} + W_{forces\ no\ conservatives}$$



# Forces no conservatives: *Fregament*

No conserven l'energia mecànica:

Introdueixen energia o la "perden" (per exemple, en forma de calor, força d'un motor, d'una persona…)




$$|\vec{P}| = |\vec{N}| = mg$$

$$|\vec{F}| - |\vec{F}_R| = |\vec{F}| - \mu_c mg = ma$$

$$W_P = W_N = 0$$

$$W_F = Fd \qquad W_{F_R} = -\mu_c mgd$$

$$W_T = Fd - \mu_c mgd = \Delta E_C = \frac{1}{2}mv^2$$

$$v = at = \frac{F - \mu_C mg}{m}t$$

$$d = \frac{1}{2}at^2 \Rightarrow t = \sqrt{\frac{2d}{a}}$$

$$v = \sqrt{2d\left(\frac{F}{m} - \mu_C g\right)}$$

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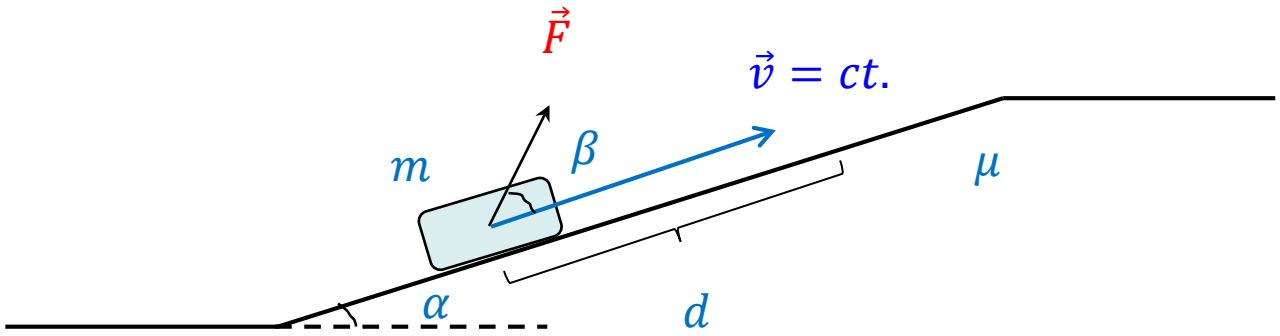
$$W_{tot} = W_{FC} + W_{FNC} = -\Delta E_P + \Delta E_M = \Delta E_c$$

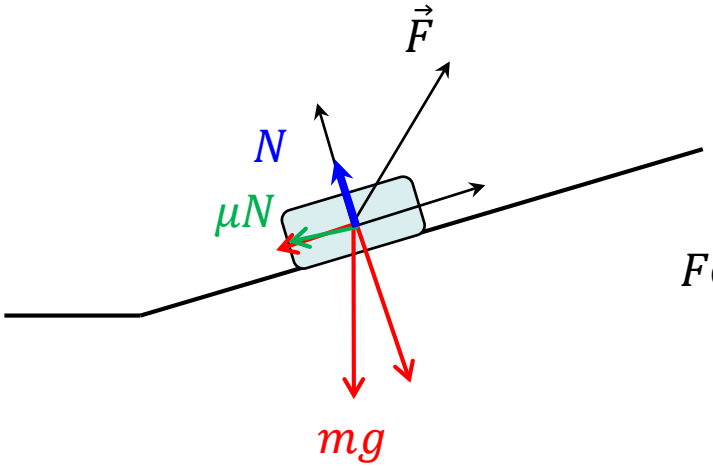
*com ja haviem vist*




Quant val la força?

Quin treball fa?

Com varia l'energía mecánica?

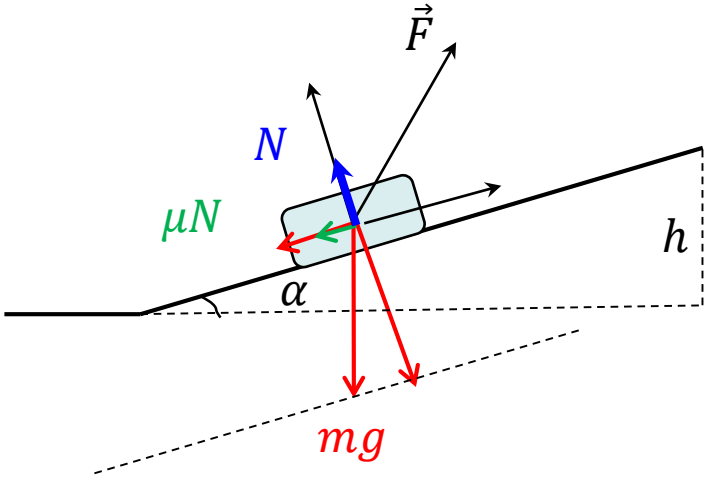



$$F\cos\beta = \mu N + mg\sin\alpha$$

$$F\sin\beta + N = mg\cos\alpha$$

$$F\cos\beta = \mu(mg\cos\alpha - F\sin\beta) + mg\sin\alpha$$

$$F = \frac{mg(\sin\alpha + \mu\cos\alpha)}{\cos\beta + \mu\sin\alpha}$$

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$$F\cos\beta = \mu(mg\cos\alpha - F\sin\beta) + mg\sin\alpha$$

$$F = \frac{mg(\sin\alpha + \mu\cos\alpha)}{\cos\beta + \mu\sin\alpha}$$

$$W_F = Fd\cos\beta \ \ [= F_x d]$$

$$W_{pes} = mgd\cos\left(\alpha + \frac{\pi}{2}\right) = -mgd\sin\alpha \ [= -P_x d]$$

$$W_{freg} = -\mu Nd = -\mu d(mg\cos\alpha - F\sin\beta)$$

$$W_N = 0$$

$$\Delta E_C = 0 \Rightarrow \ W_T = 0$$

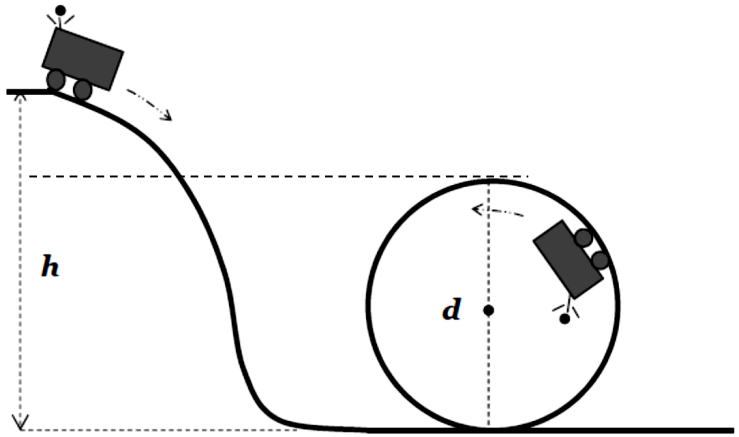
$$\Delta E_P = -W_{FC} = -W_{mg} = mgh$$

$$\Delta E_M = W_{FNC} = W_F + W_{freg}$$

# Problema del ris

*Quina és l'altura mínima inicial per a que el carretó doni una volta completa?*

~~$h_{mín} = d$~~




$\mu = 0$