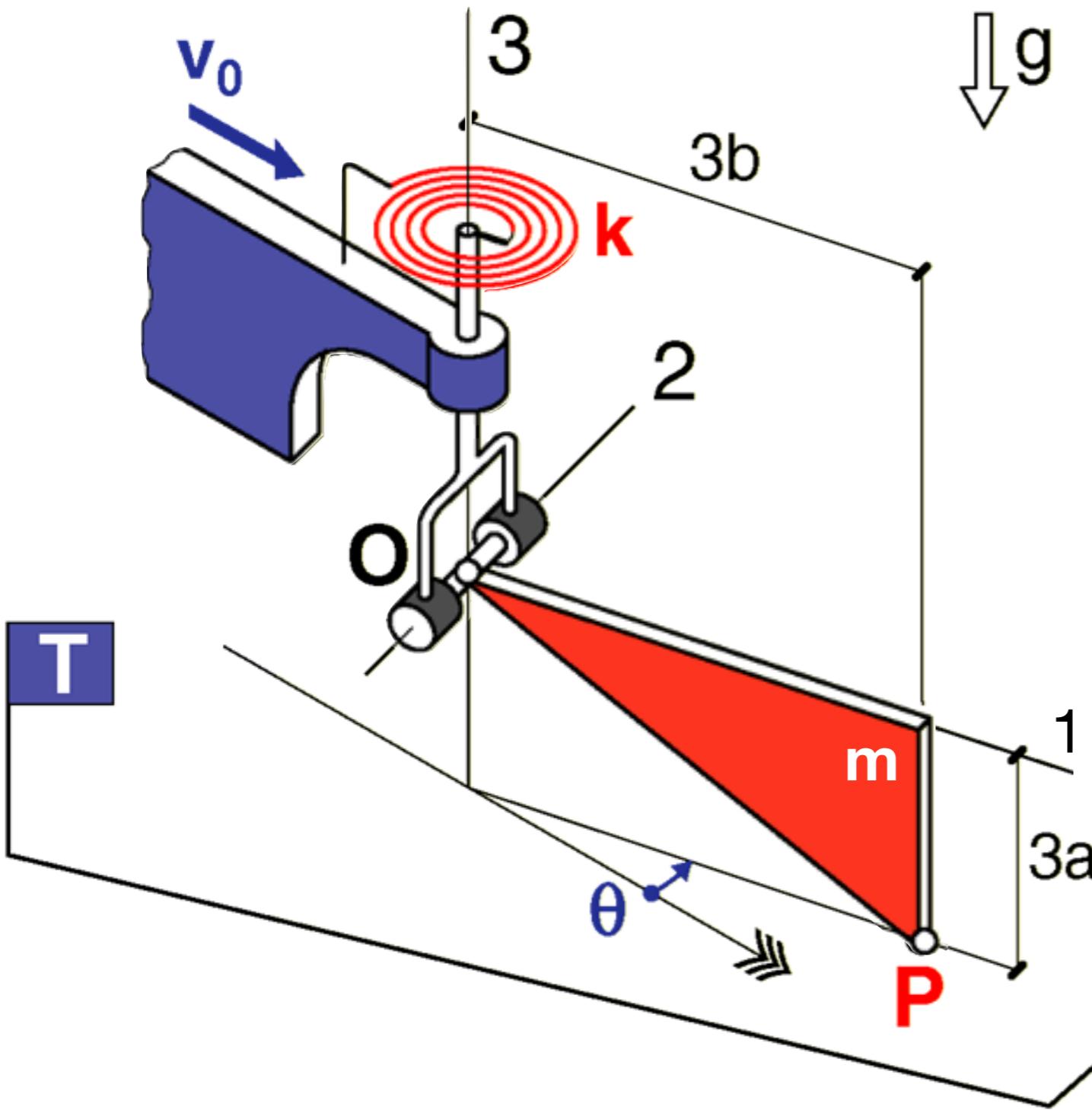


# 12P

## Teoremes vectorials II

Exemples 3D

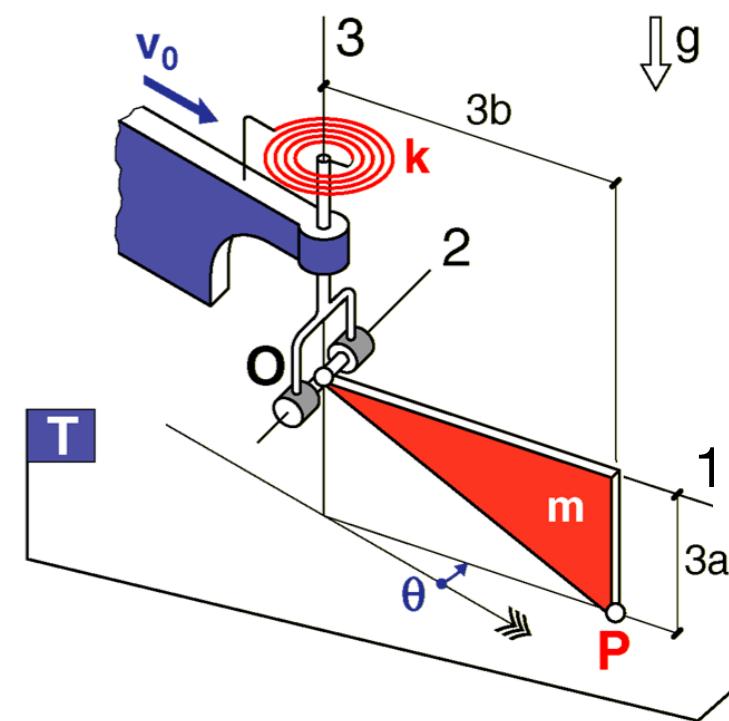
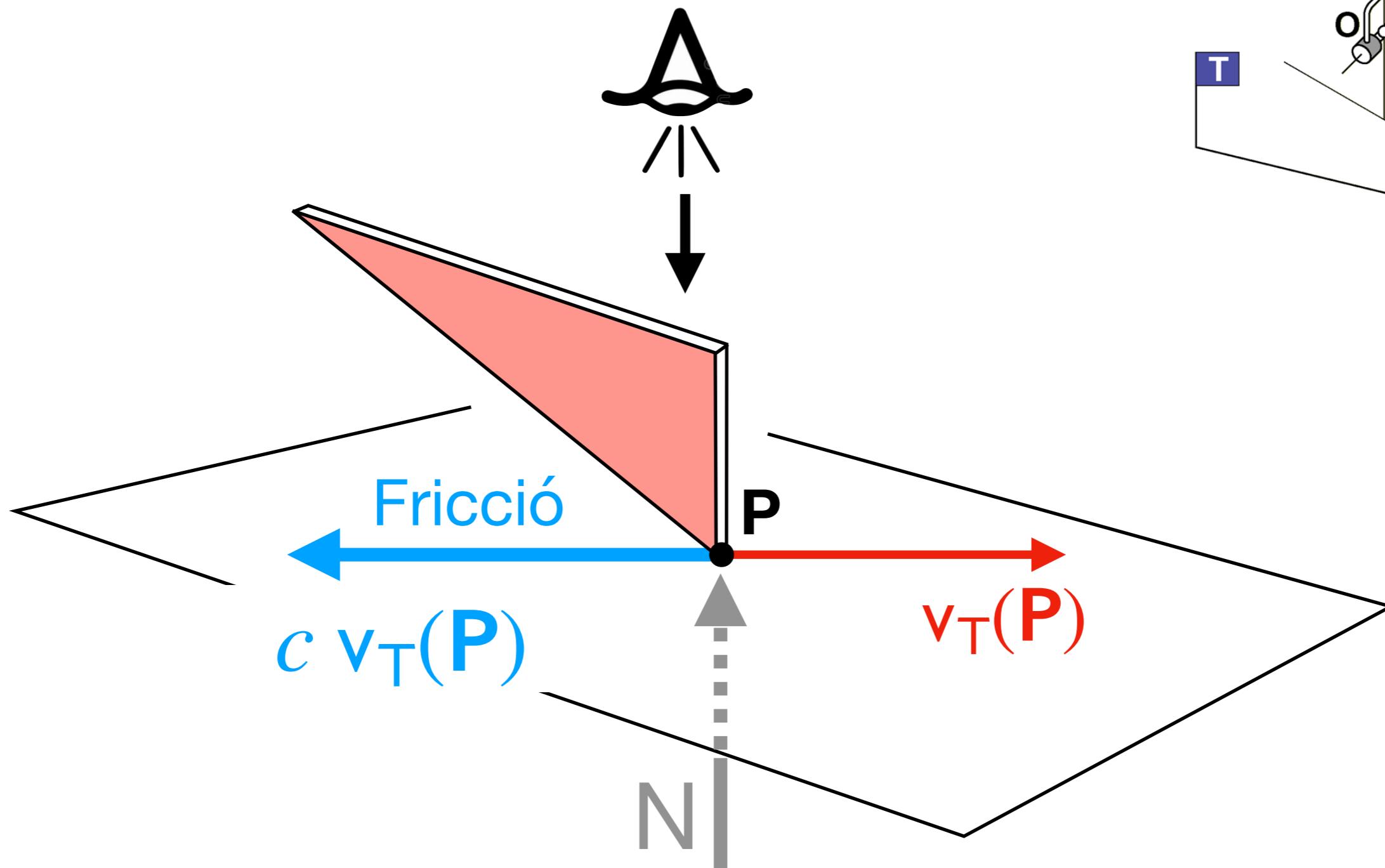
- Eq. mov. per a  $\theta$  ?
- $k_{\min}$  per a que  $\theta_{\text{eq}} = 0$   
sigui **ESTABLE** ?



$\exists$  freq viscós  $T \rightarrow P$   
(de coef  $c$ )

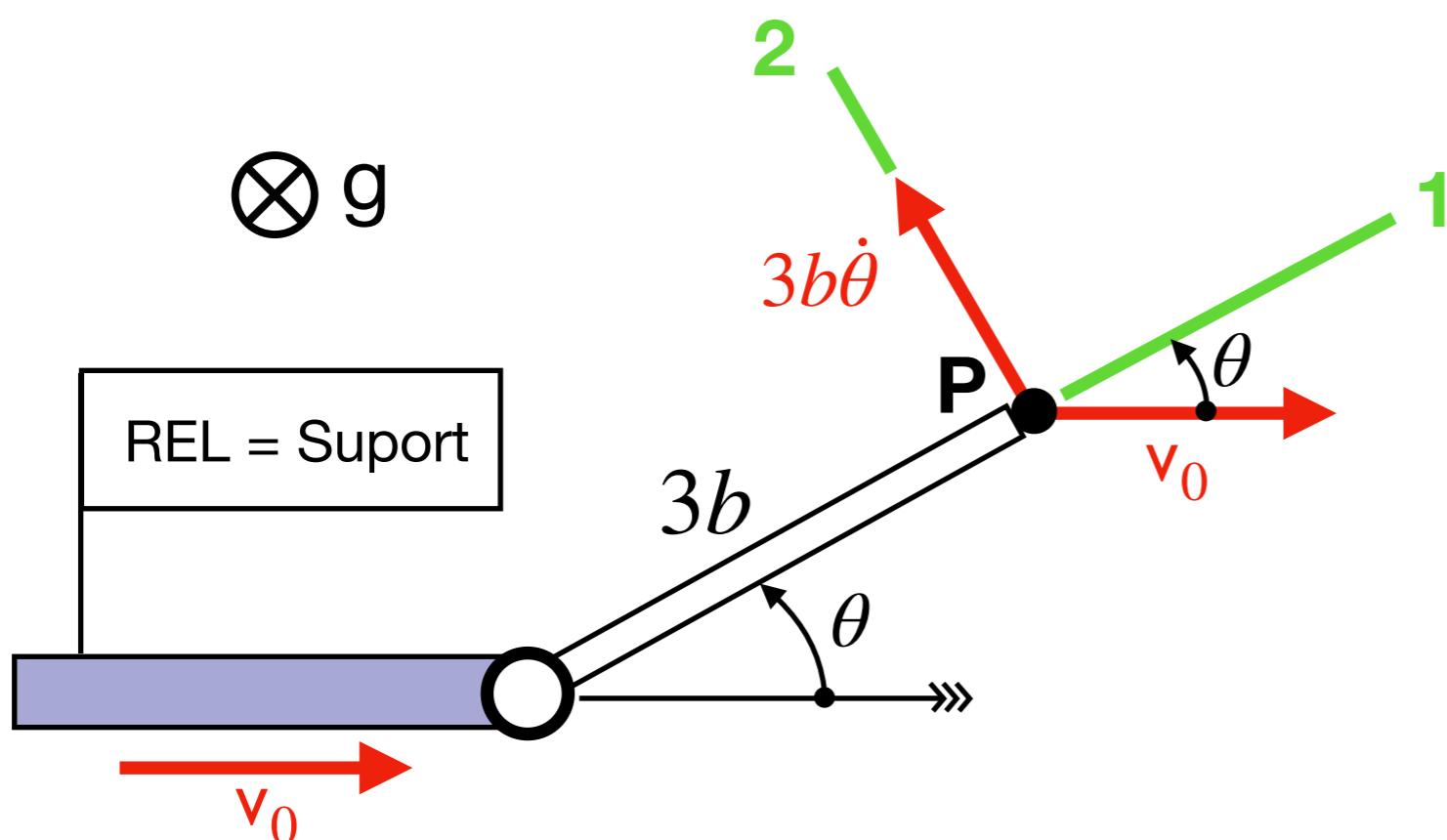
Per  $\theta = 0$  la molla  
està distesa

# Força de freq viscós $T \rightarrow P$



$$\bar{F}_{fv} = -c \bar{v}_T(P)$$

# Força de freq viscós $T \rightarrow P$

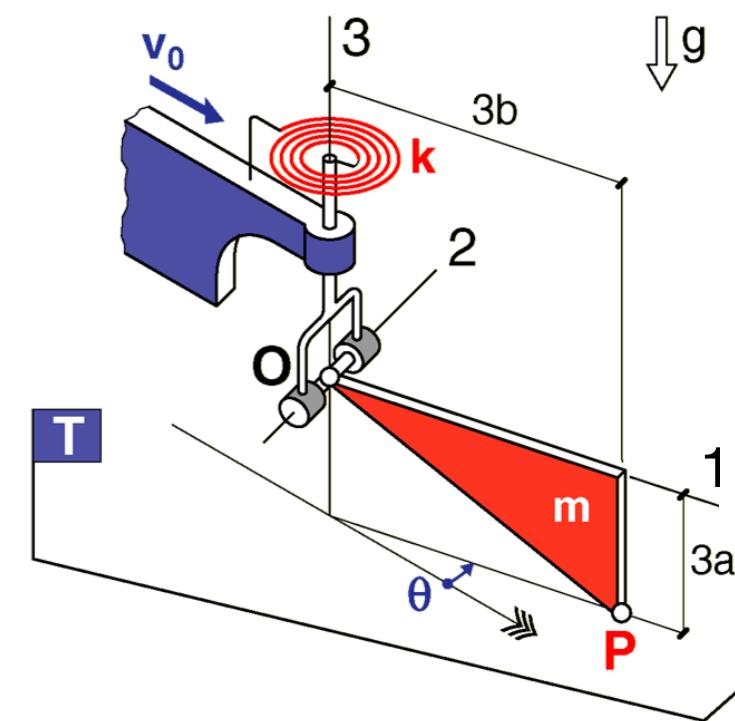


$$\bar{v}_T(P) = \bar{v}_{REL}(P) + \bar{v}_{ar}(P) = \begin{Bmatrix} v_0 \cos \theta \\ -v_0 \sin \theta + 3b\dot{\theta} \\ 0 \end{Bmatrix} \quad B=(1,2,3)$$

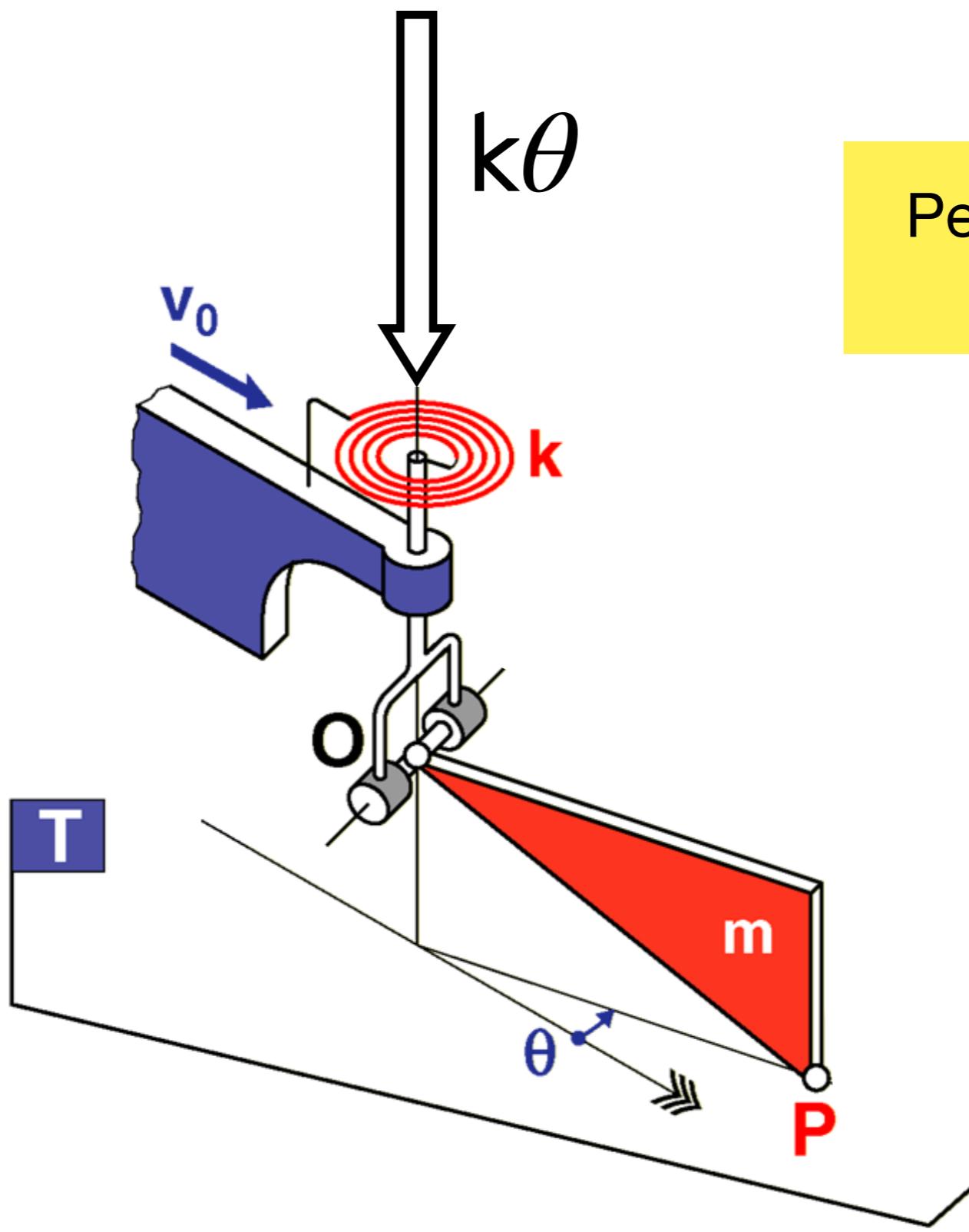
$$\bar{F}_{fv} = -c \bar{v}_T(P) = \begin{Bmatrix} -cv_0 \cos \theta \\ cv_0 \sin \theta - 3cb\dot{\theta} \\ 0 \end{Bmatrix} \quad B$$

$F_{fv1}$

$F_{fv2}$



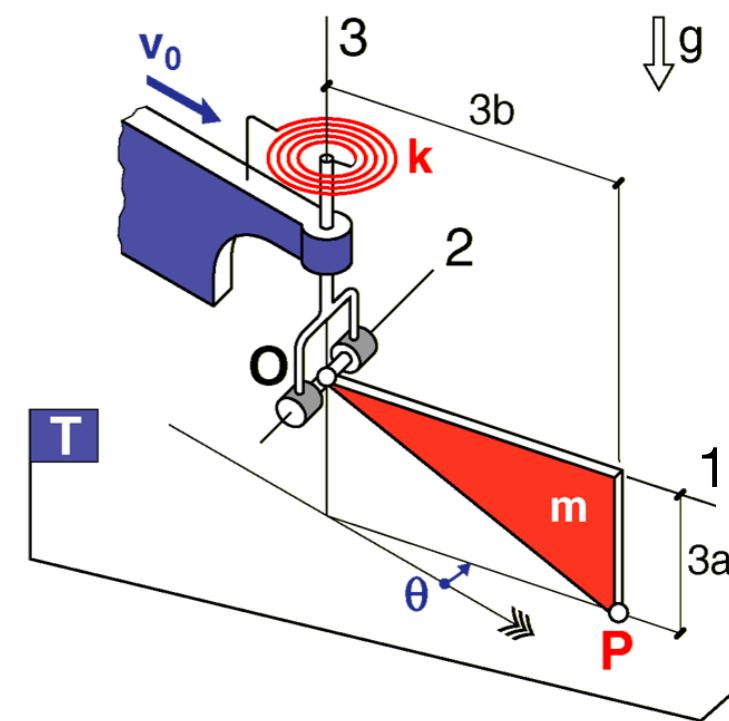
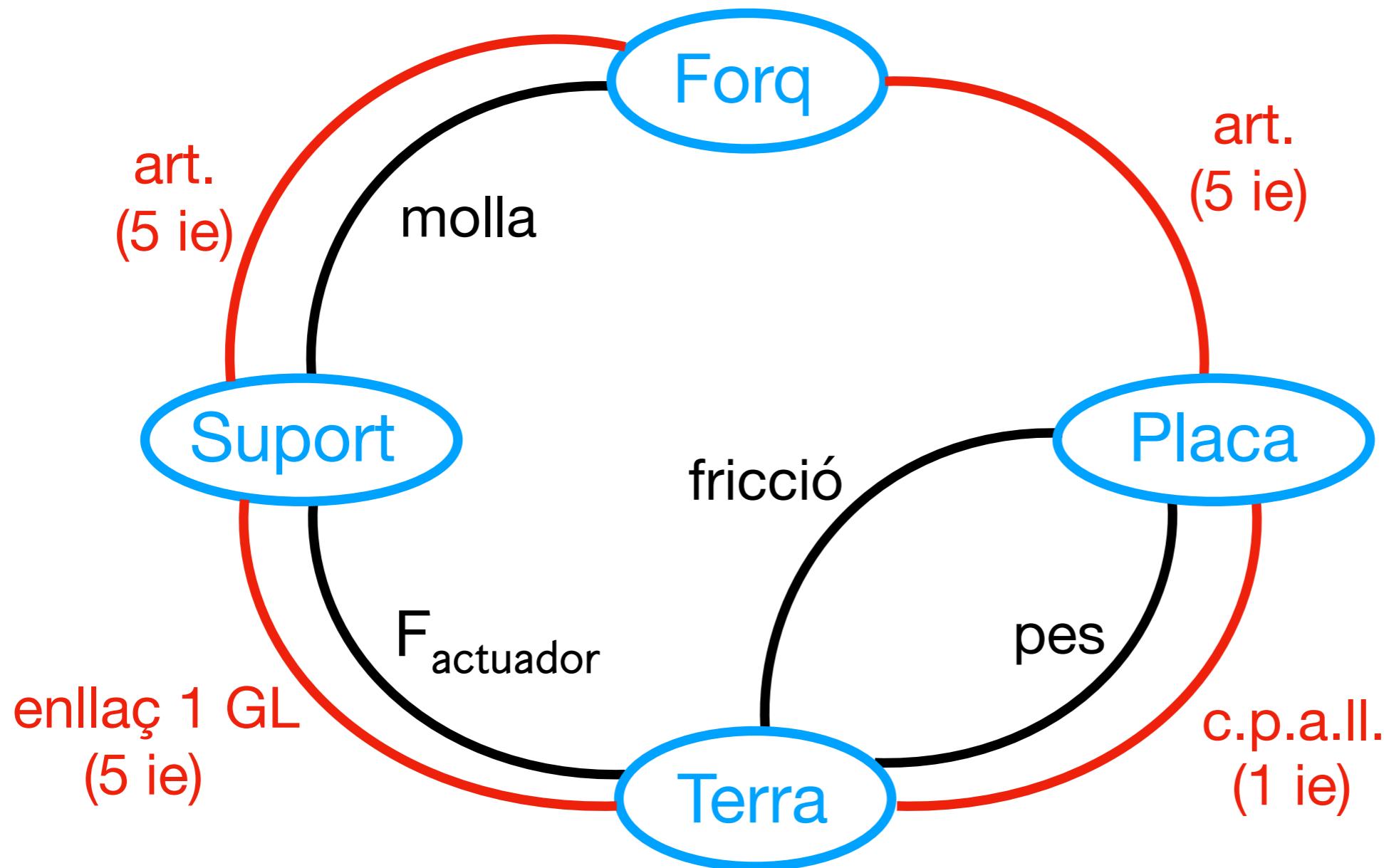
# Parell molla torsional → forq



Per  $\theta = 0$  la molla  
è distesa

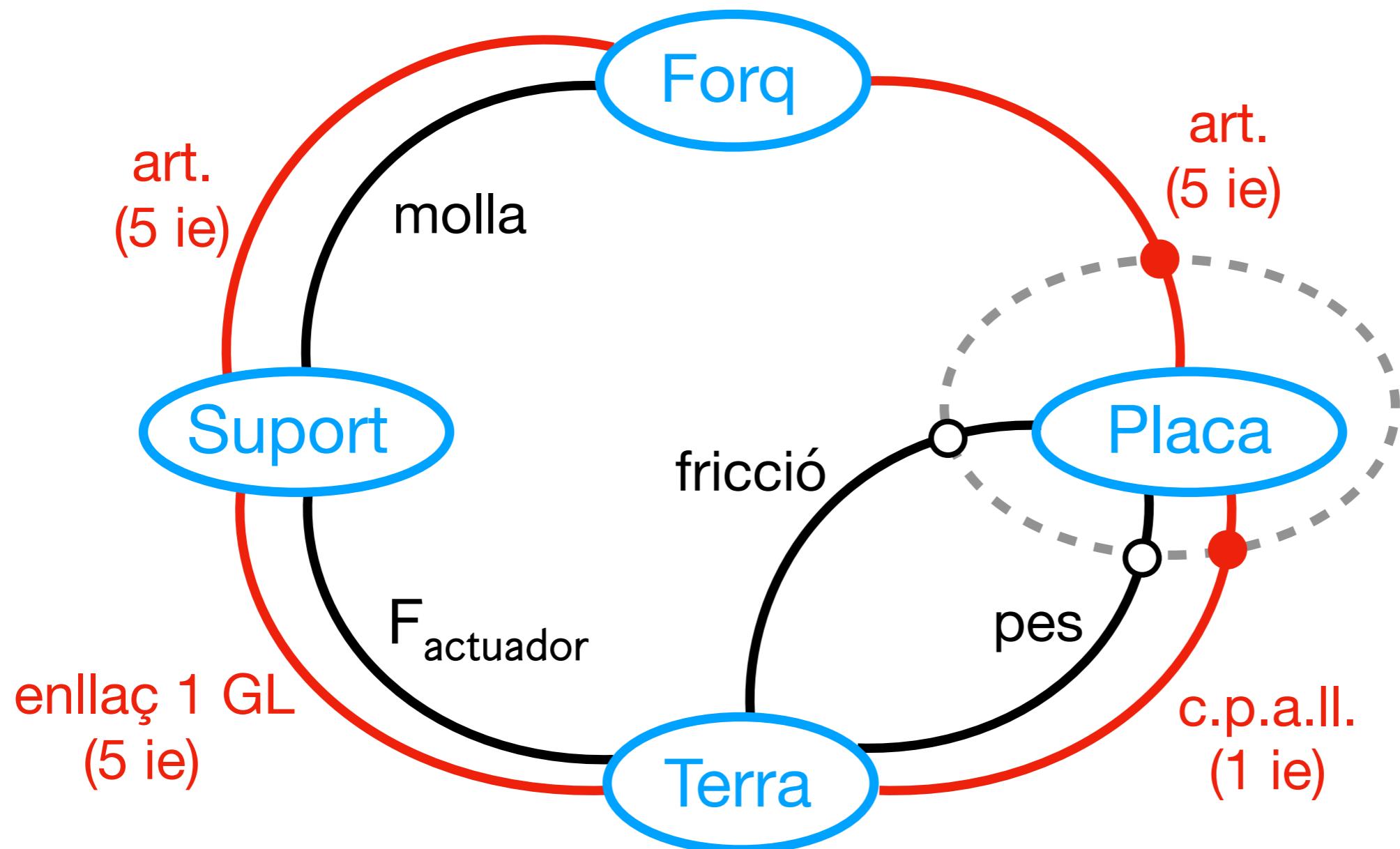
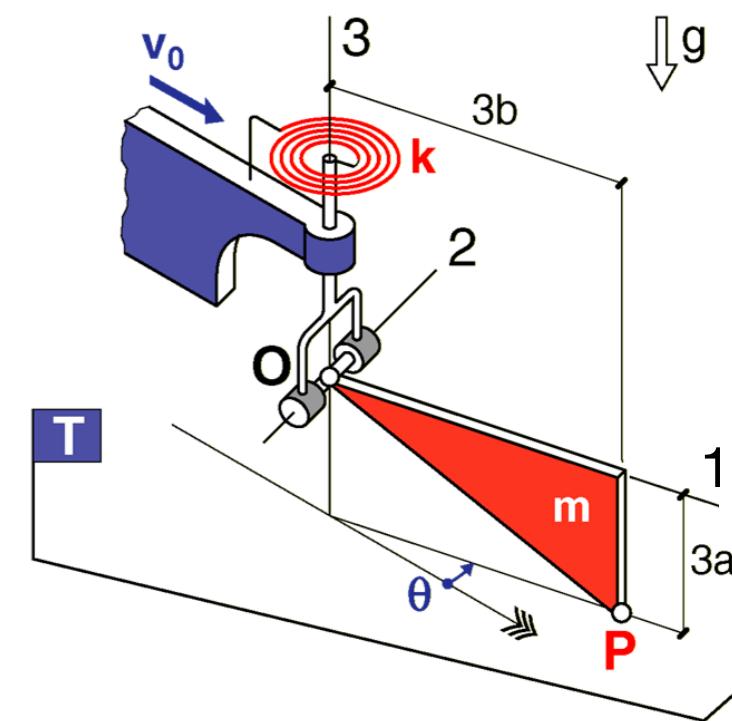
# DGI

= Diagrama general  
d'interaccions



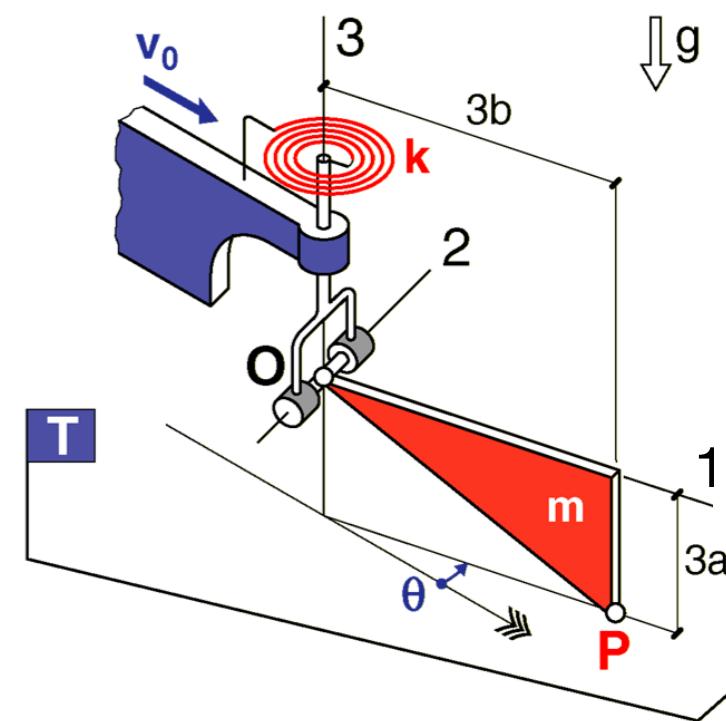
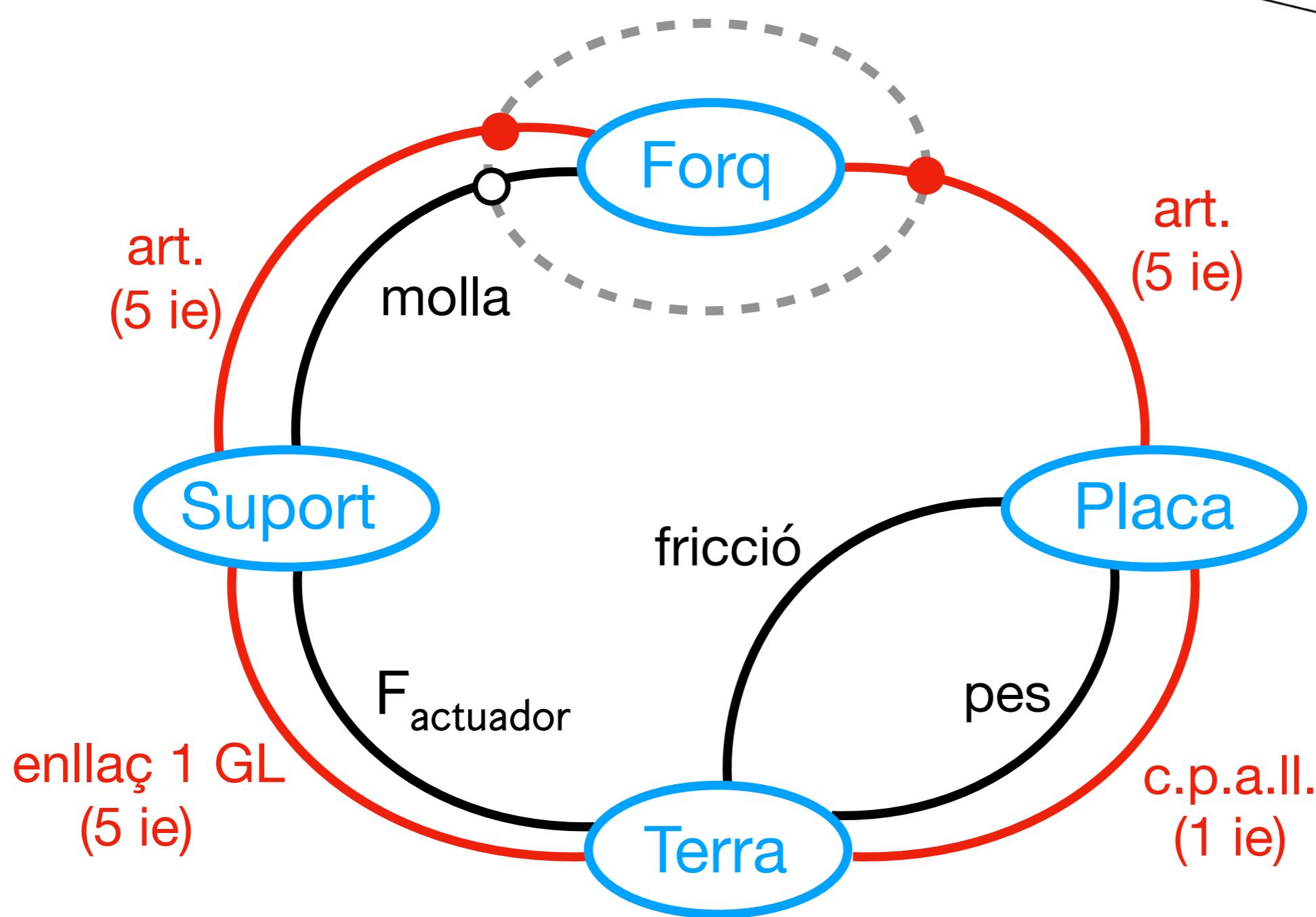
**INDET**

{ Sist = Placa  
6 ie +  $\ddot{\theta}$  = 7 incòg



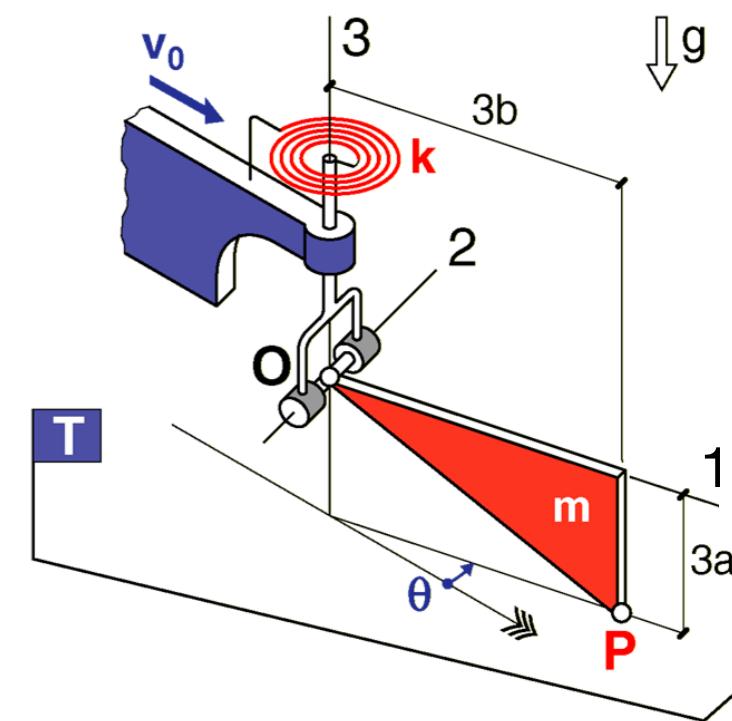
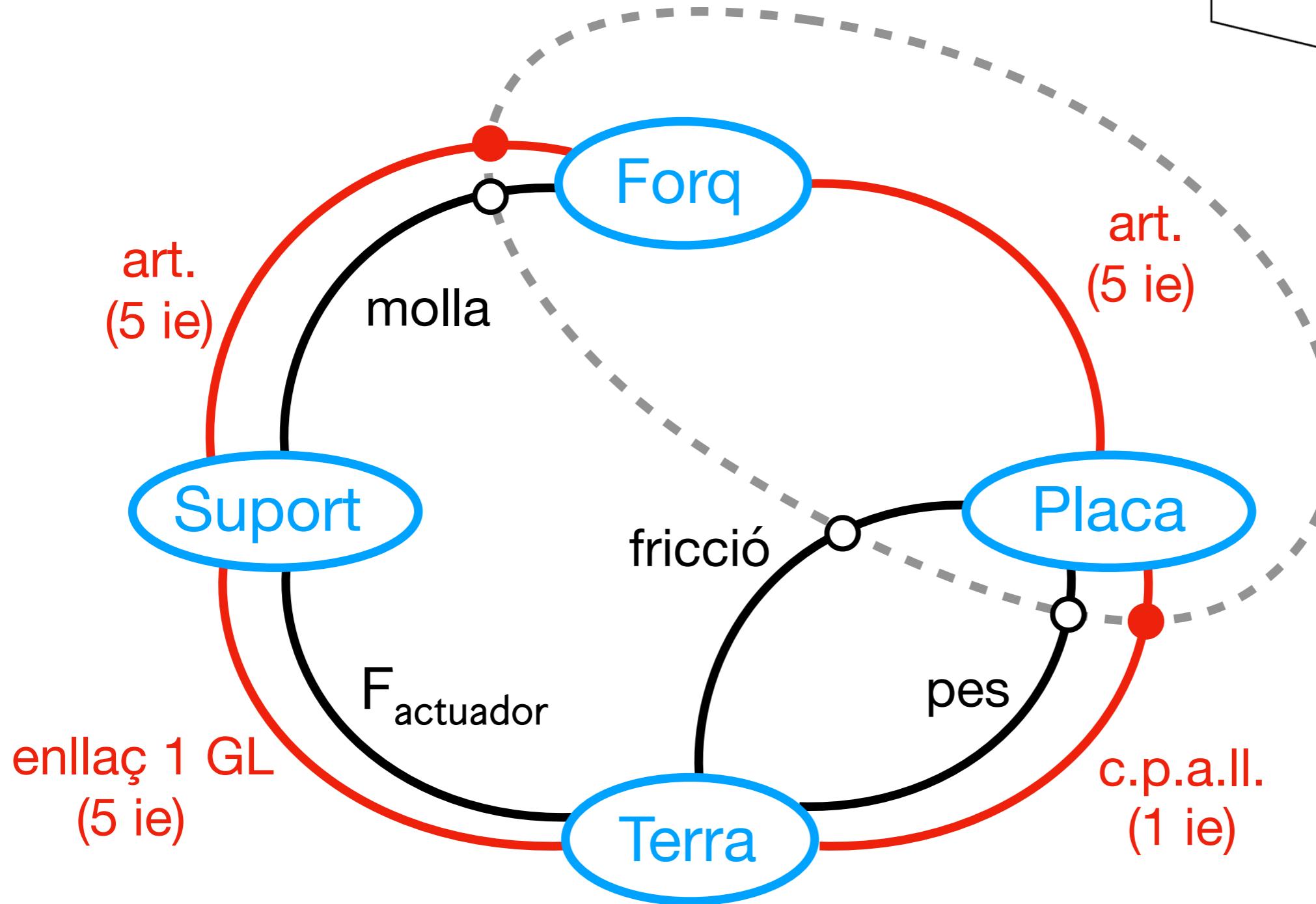
**INDET**

$$\left\{ \begin{array}{l} \text{Sist} = \text{Forq} \\ 10 \text{ ie} + \ddot{\theta} = 11 \text{ incòg} \end{array} \right.$$

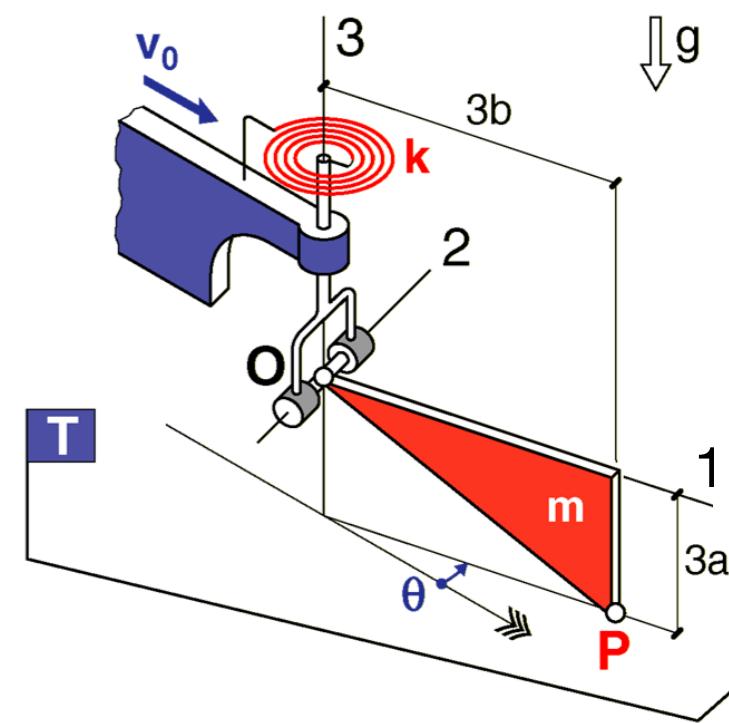
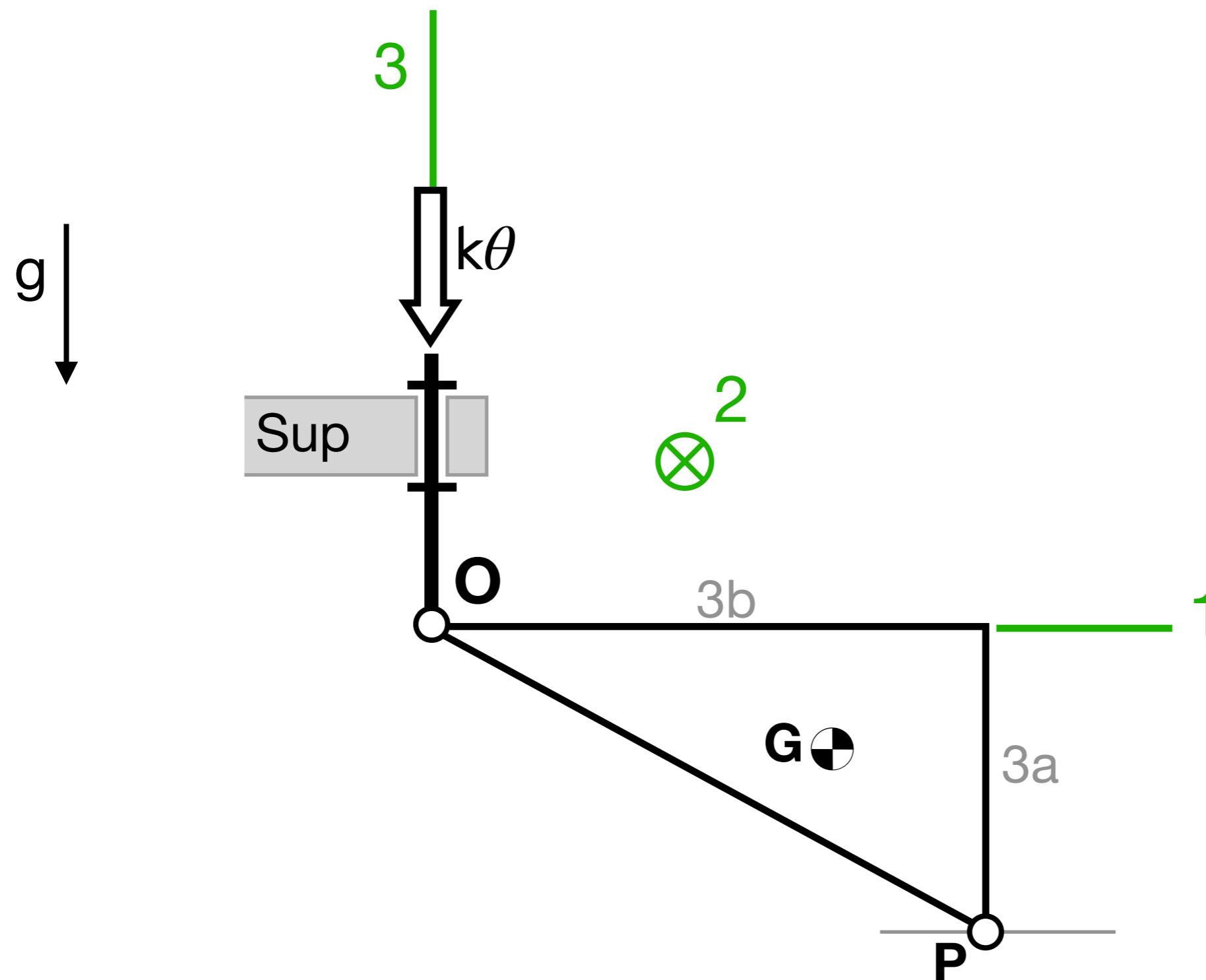


**INDET**

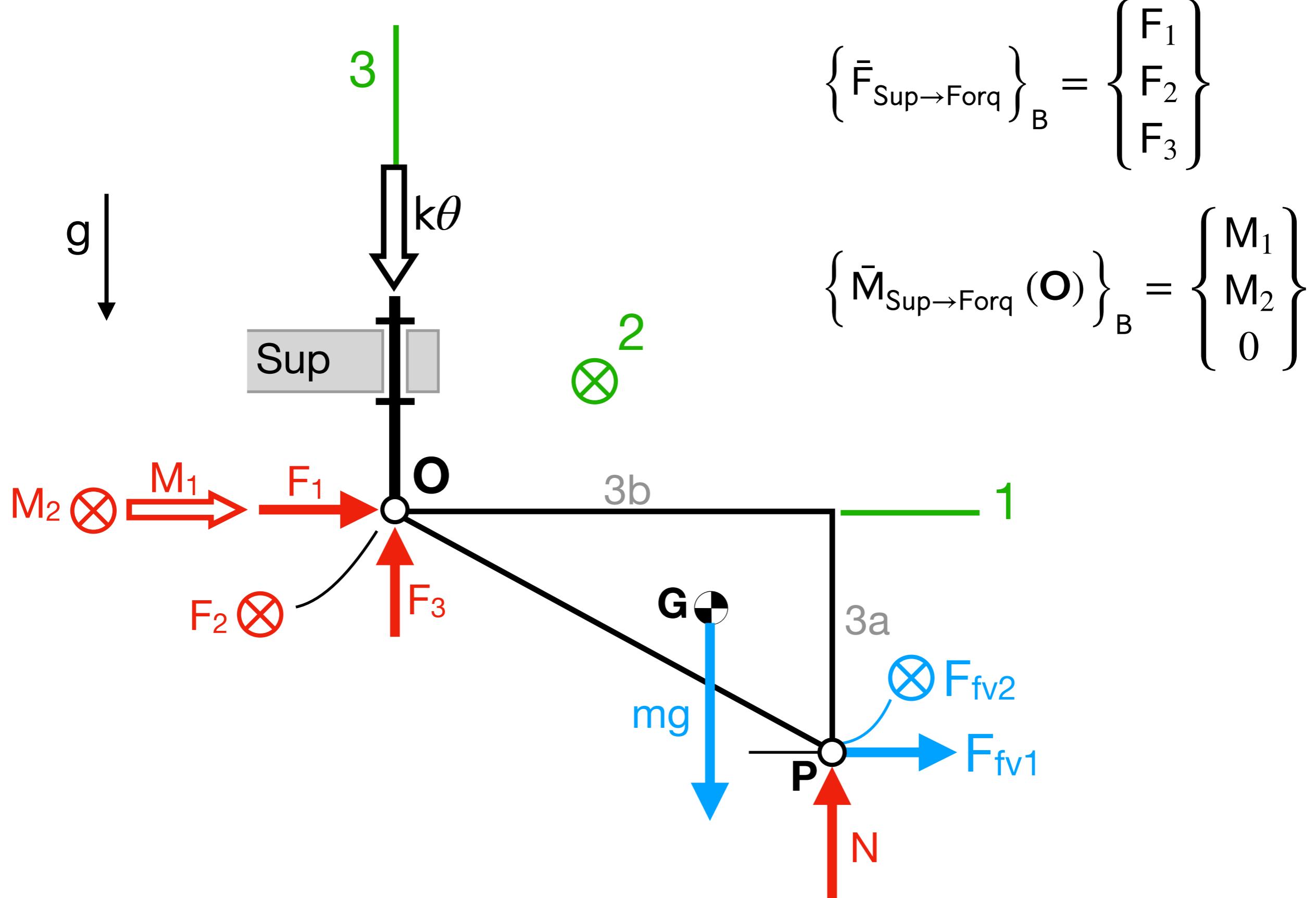
{ Sist = Placa + Forq  
6 ie +  $\ddot{\theta}$  = 7 incòg



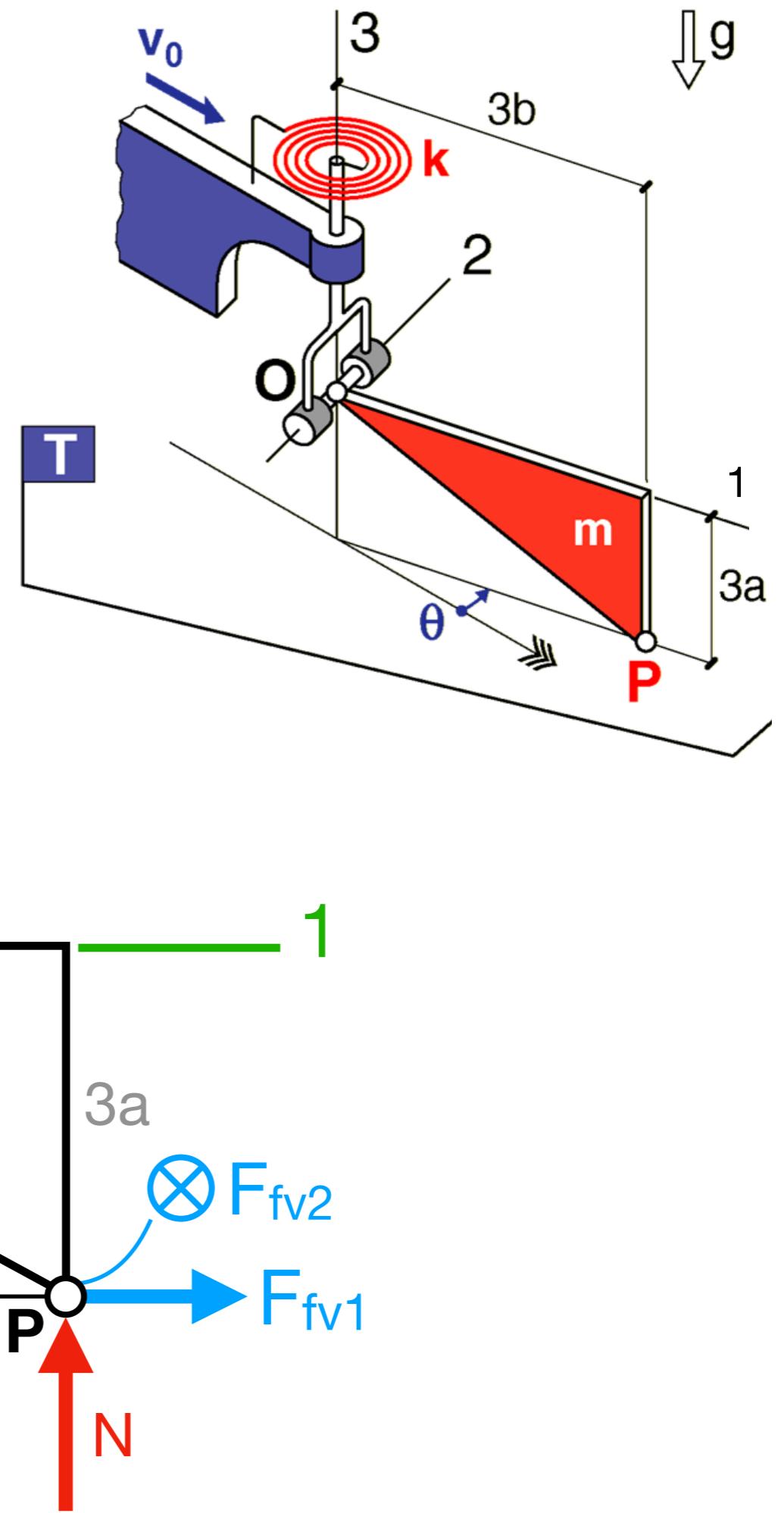
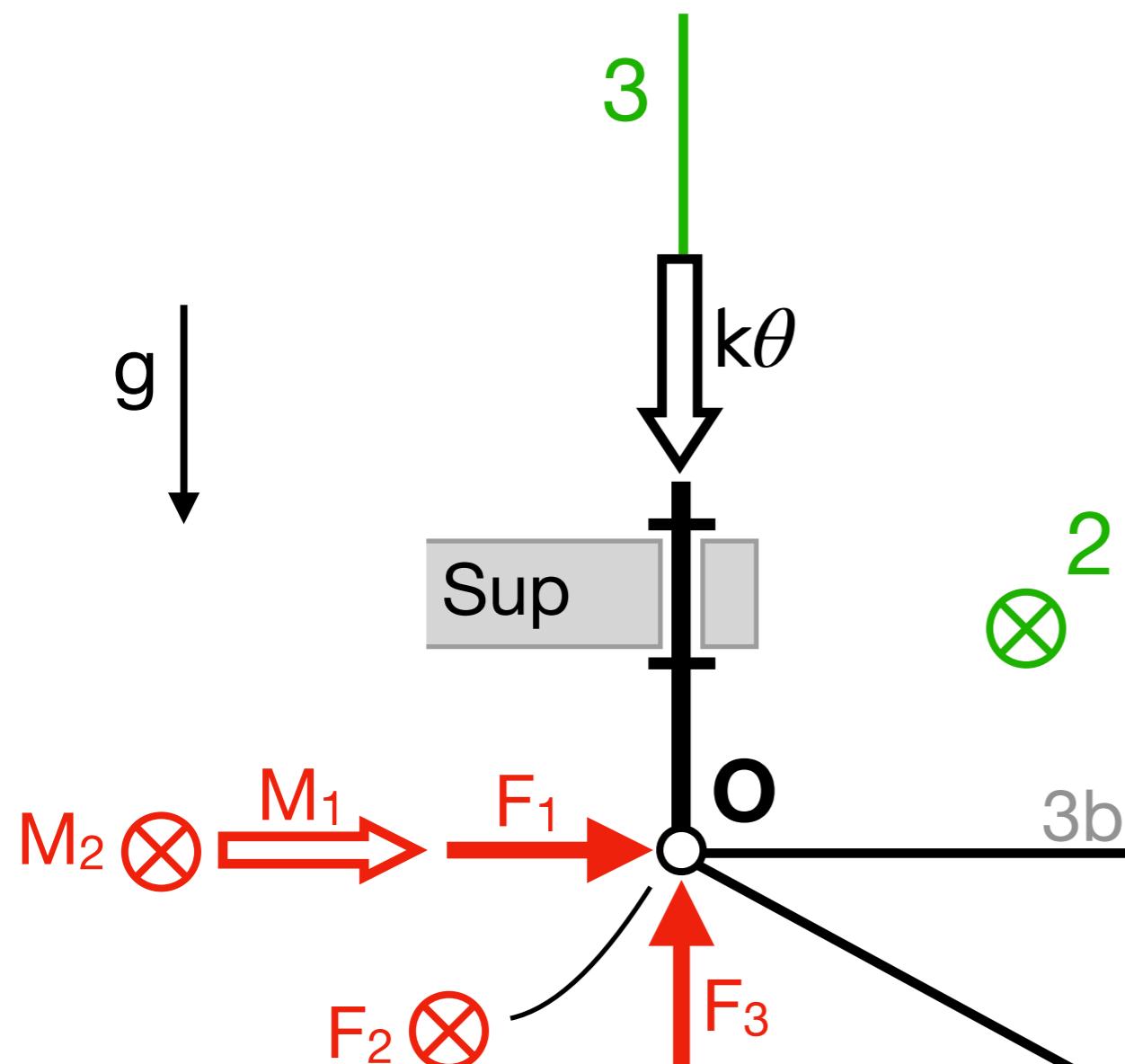
# Forces sobre "Placa + Forq"



# Forces sobre "Placa + Forq"



# Forces sobre "Placa + Forq"



# Anàlisi de l'estabilitat de $\theta_{eq} = 0$

3 passos

com al pèndol simple

$$I_{33} \ddot{\theta} + 9cb^2 \dot{\theta} + k \theta - 3bcv_0 \sin \theta = 0$$

Obtenim EDO  
de l'error  $\varepsilon$

$$\begin{aligned}\theta &= \theta_{eq} + \varepsilon \\ \dot{\theta} &= \dot{\varepsilon} \\ \ddot{\theta} &= \ddot{\varepsilon}\end{aligned}$$

$\overline{\varepsilon} = \varepsilon$   
en aquest exemple

$$I_{33} \ddot{\varepsilon} + 9cb^2 \dot{\varepsilon} + k \varepsilon - 3bcv_0 \sin \varepsilon = 0$$

La linealitzem  
 $\sin \varepsilon \approx \varepsilon$

$$I_{33} \ddot{\varepsilon} + 9cb^2 \dot{\varepsilon} + (k - 3bcv_0) \varepsilon = 0$$

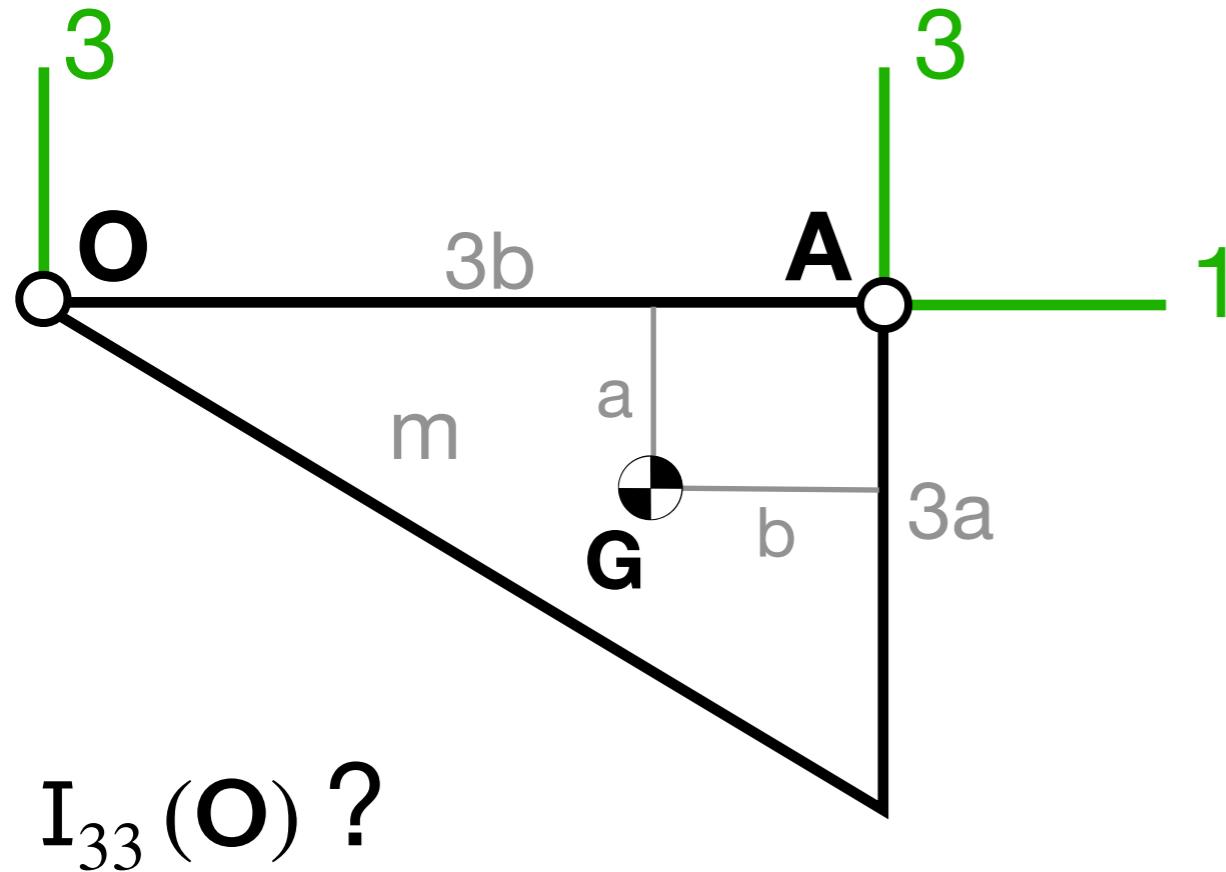
**A**                    **B**

$$\ddot{\varepsilon} = -\frac{B}{I_{33}} \varepsilon - \frac{A}{I_{33}} \dot{\varepsilon}$$

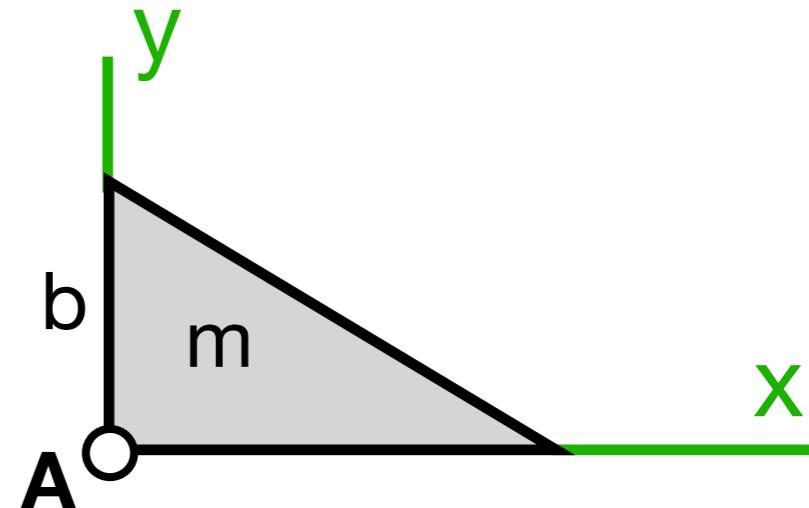
**K**                    **C**  $> 0$

K > 0?

$$K > 0 \iff B > 0 \iff k > 3bcv_0$$



Taules



$$I_{xx}(A) = \frac{1}{6}mb^2$$

$I_{33}(A)$  de taules + **doble Steiner** per passar de **A** a **O**:

$$(a) \quad I_{33}(O) = I_{33}(G) + I_{33}^\oplus(O)$$

$$(b) \quad I_{33}(A) = I_{33}(G) + I_{33}^\oplus(A)$$


---

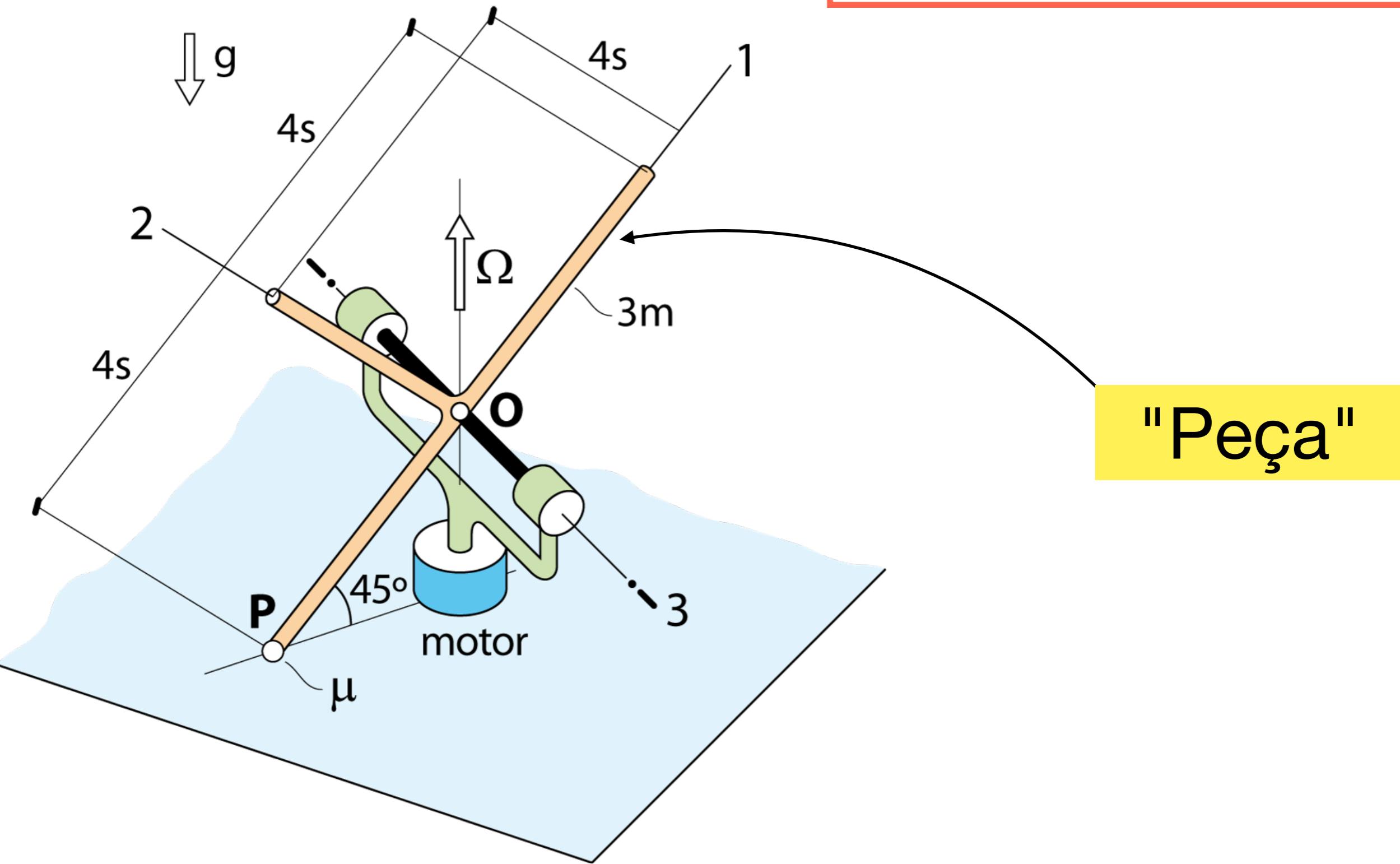
$$(a - b) \quad I_{33}(O) = I_{33}(A) + I_{33}^\oplus(O) - I_{33}^\oplus(A)$$

$$I_{33}(O) = \frac{1}{6}m(3b)^2 + m(2b)^2 - mb^2 = \frac{9}{2}mb^2$$

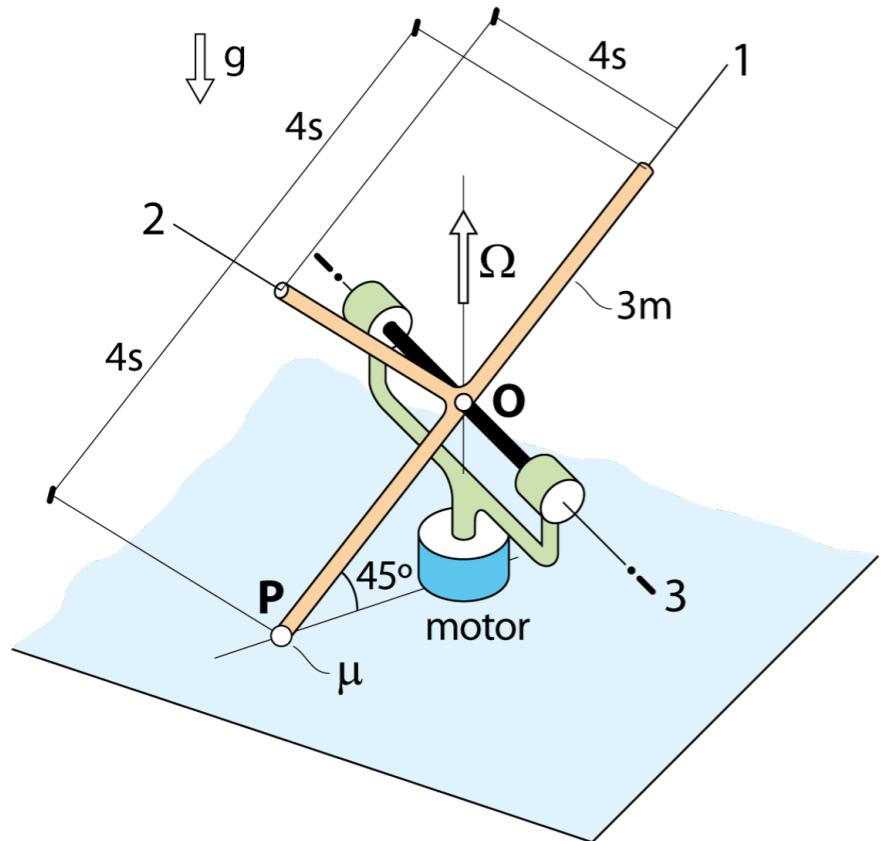
$$\Omega_{\text{T}}^{\text{forq}} = \Omega = \text{ct}$$

$\Omega_{\text{critica}}$  per pèrdua contacte a P?

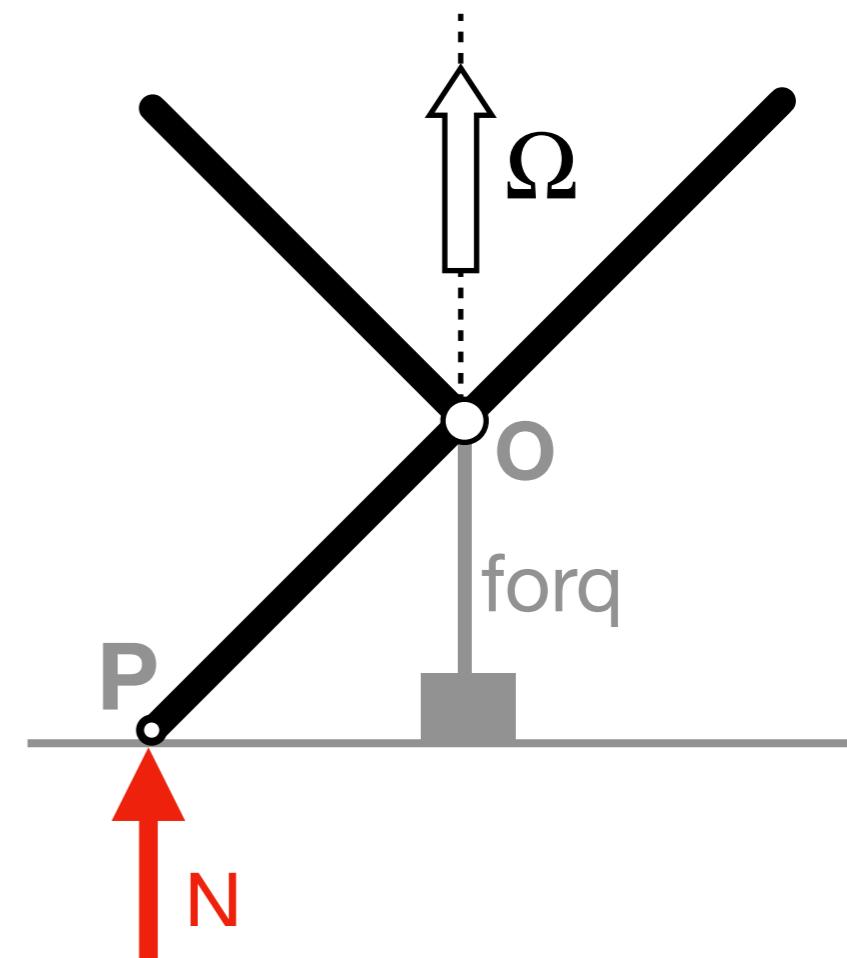
Eq. mov. quan  $\Omega > \Omega_{\text{critica}}$



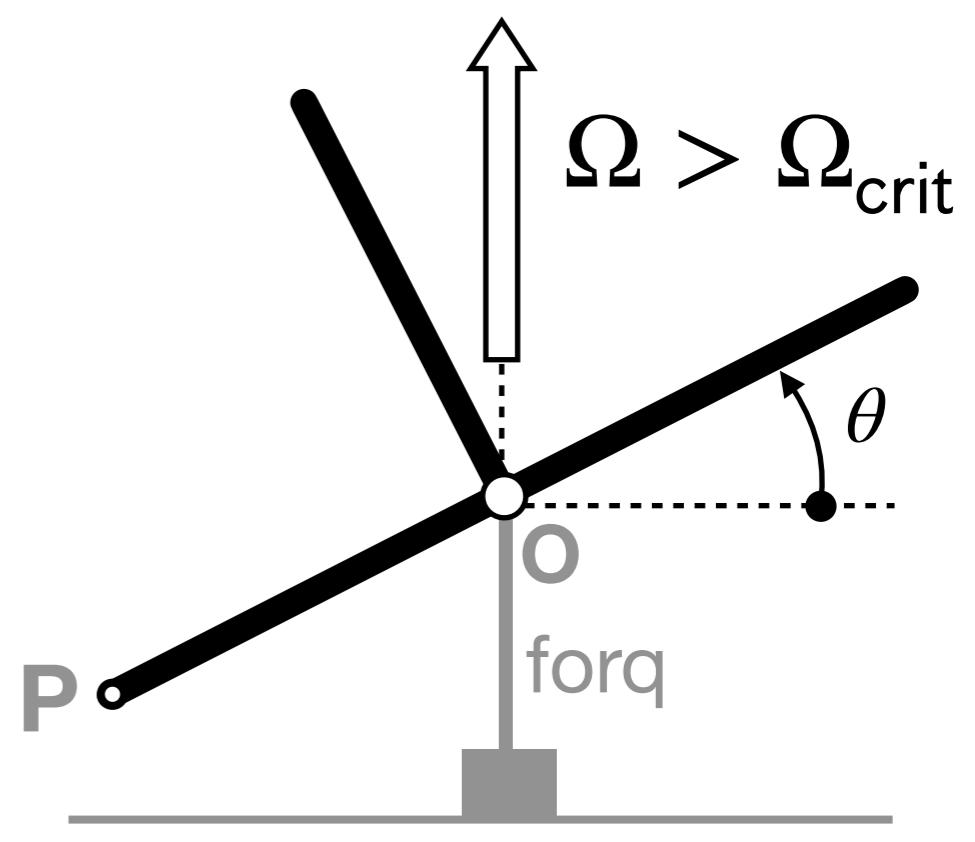
# GL? 2 situacions!

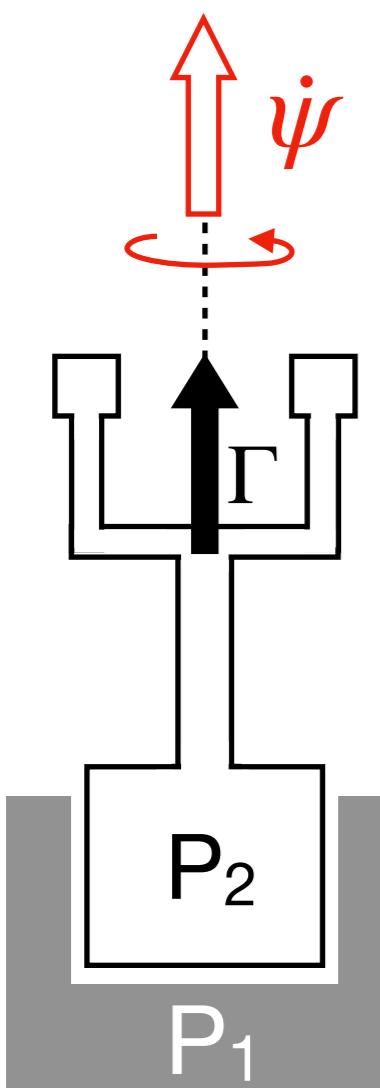
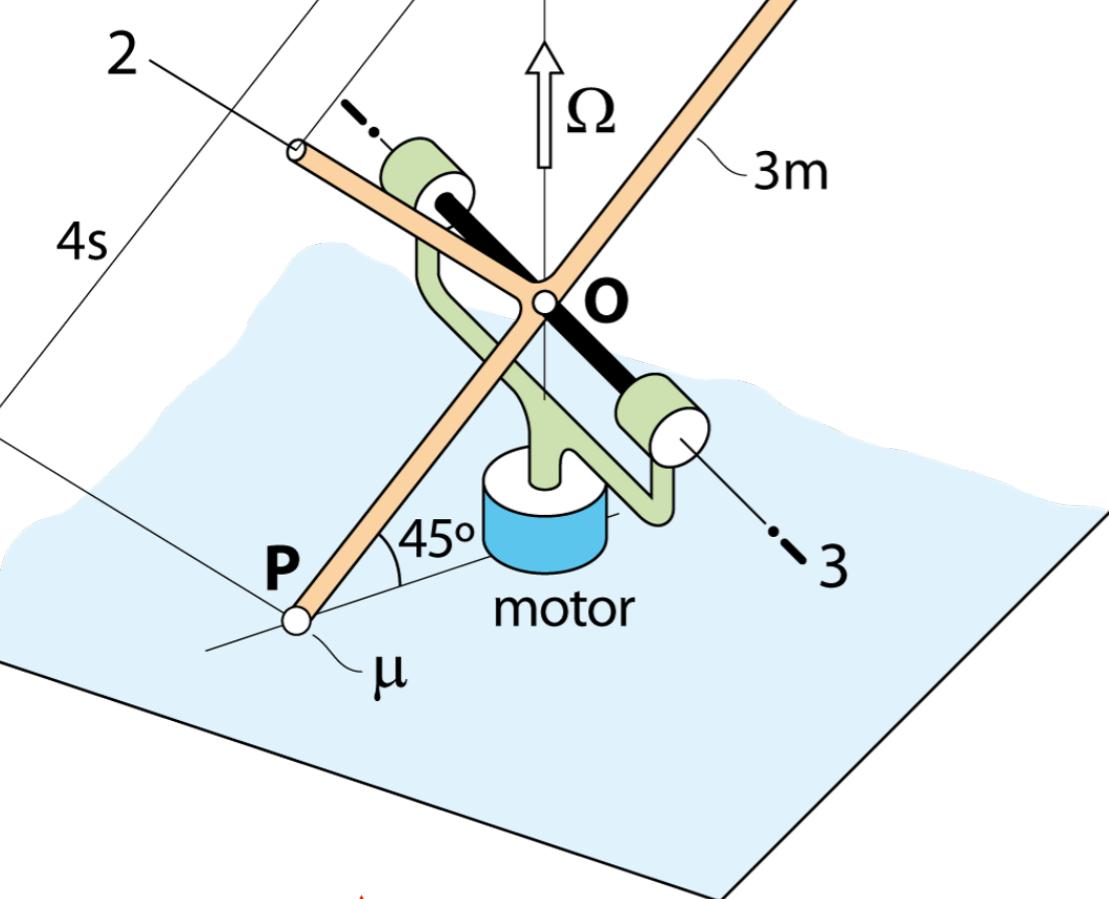


**P** manté contacte amb T



Contacte perdat





Recordeu

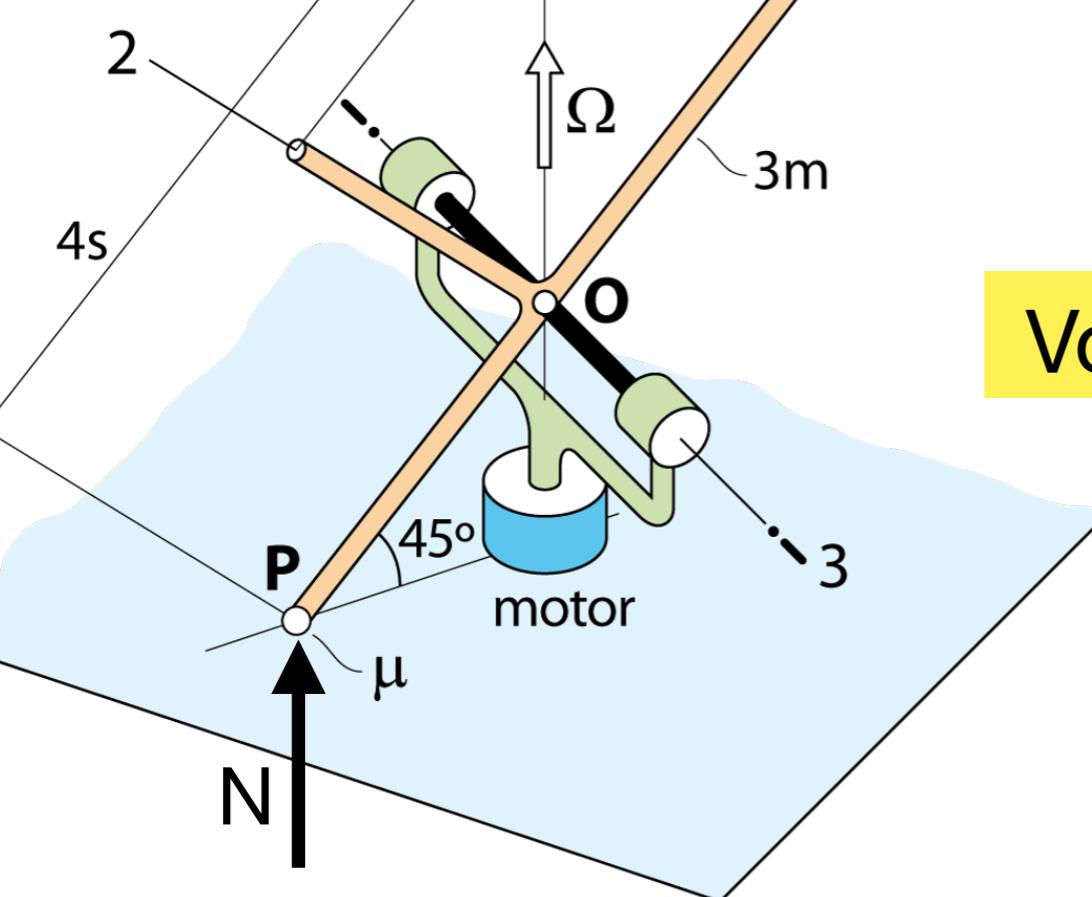
$\Gamma$  coneugut  $\Rightarrow \ddot{\psi}$  és incògnita

$\ddot{\psi}$  coneguda  $\Rightarrow \Gamma$  és incògnita

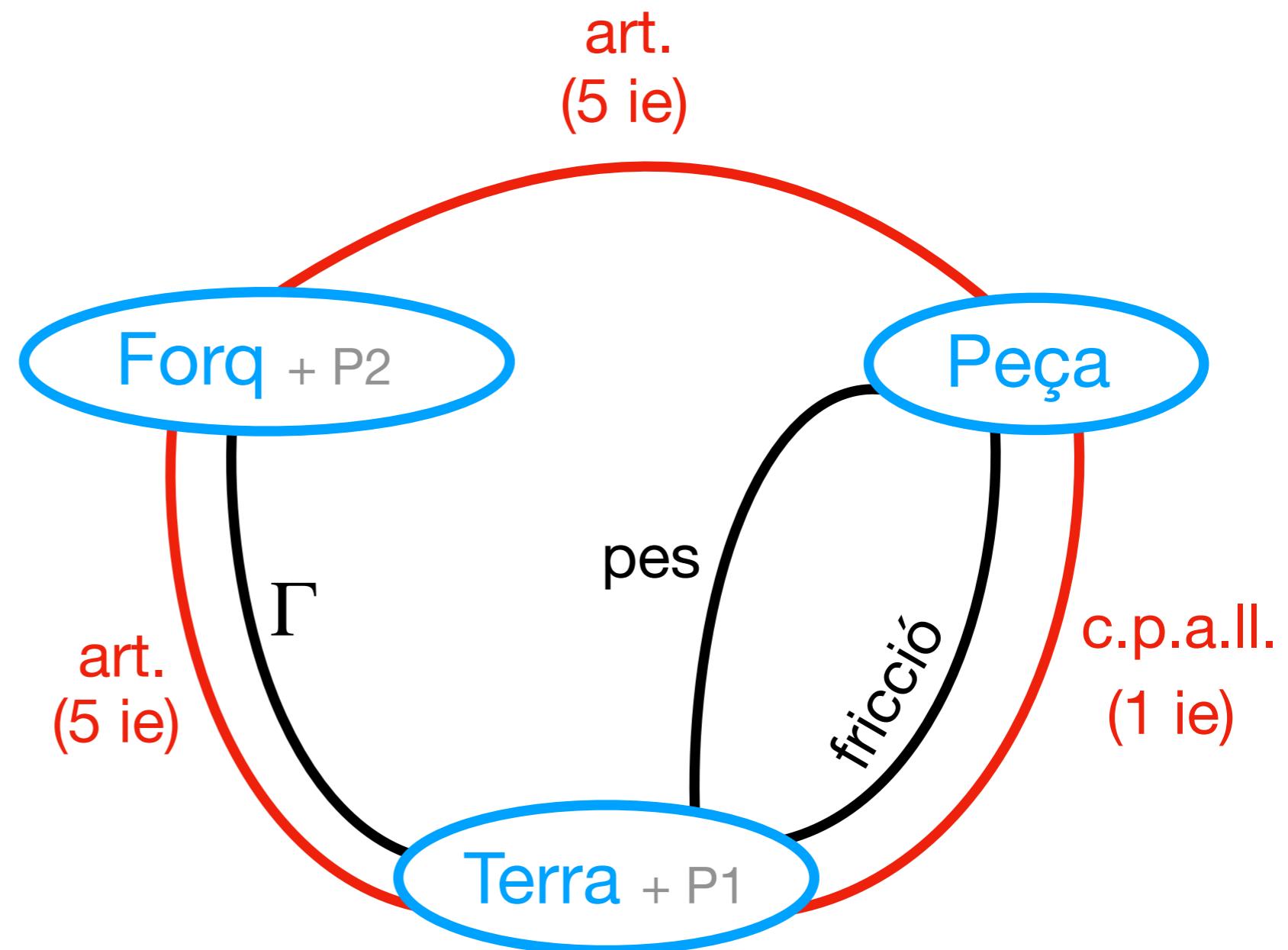
En aquest exercici

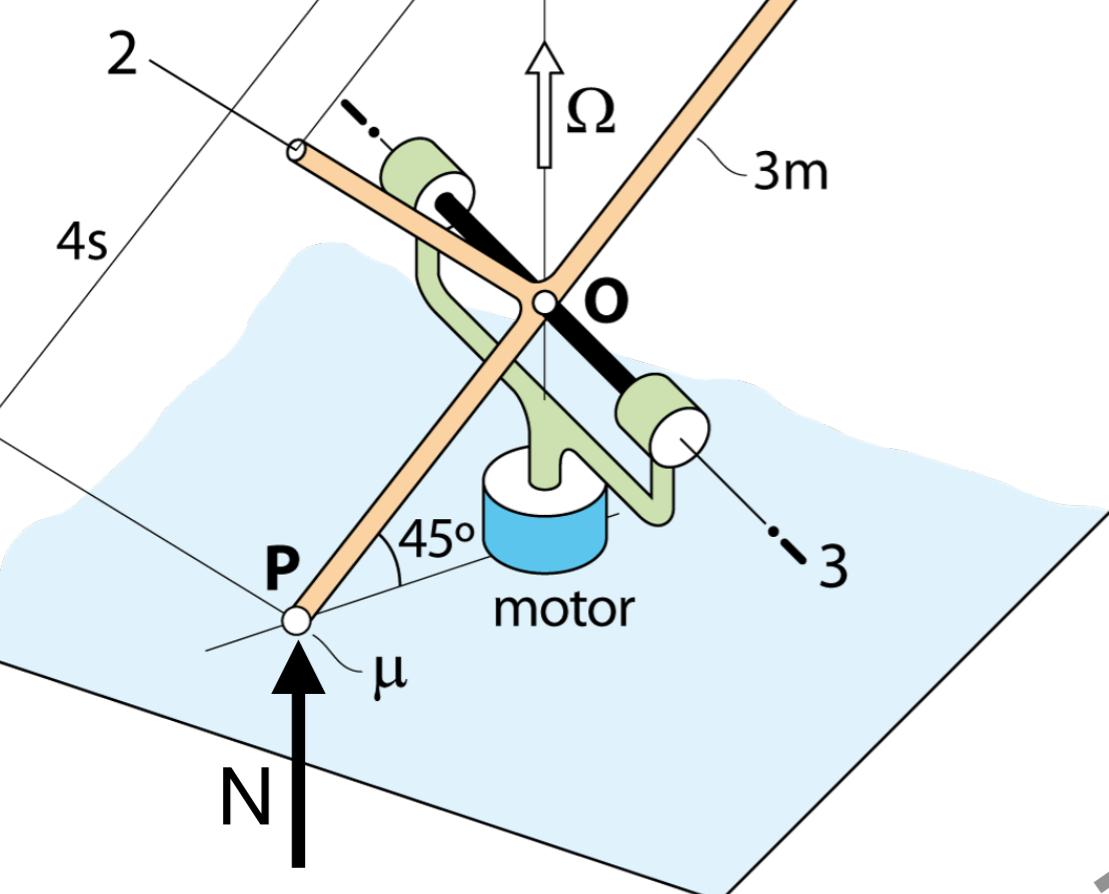
$\dot{\psi} = \Omega = ct \Rightarrow \dot{\psi} = 0$  (coneuguda)

$\Gamma$  serà incògnita

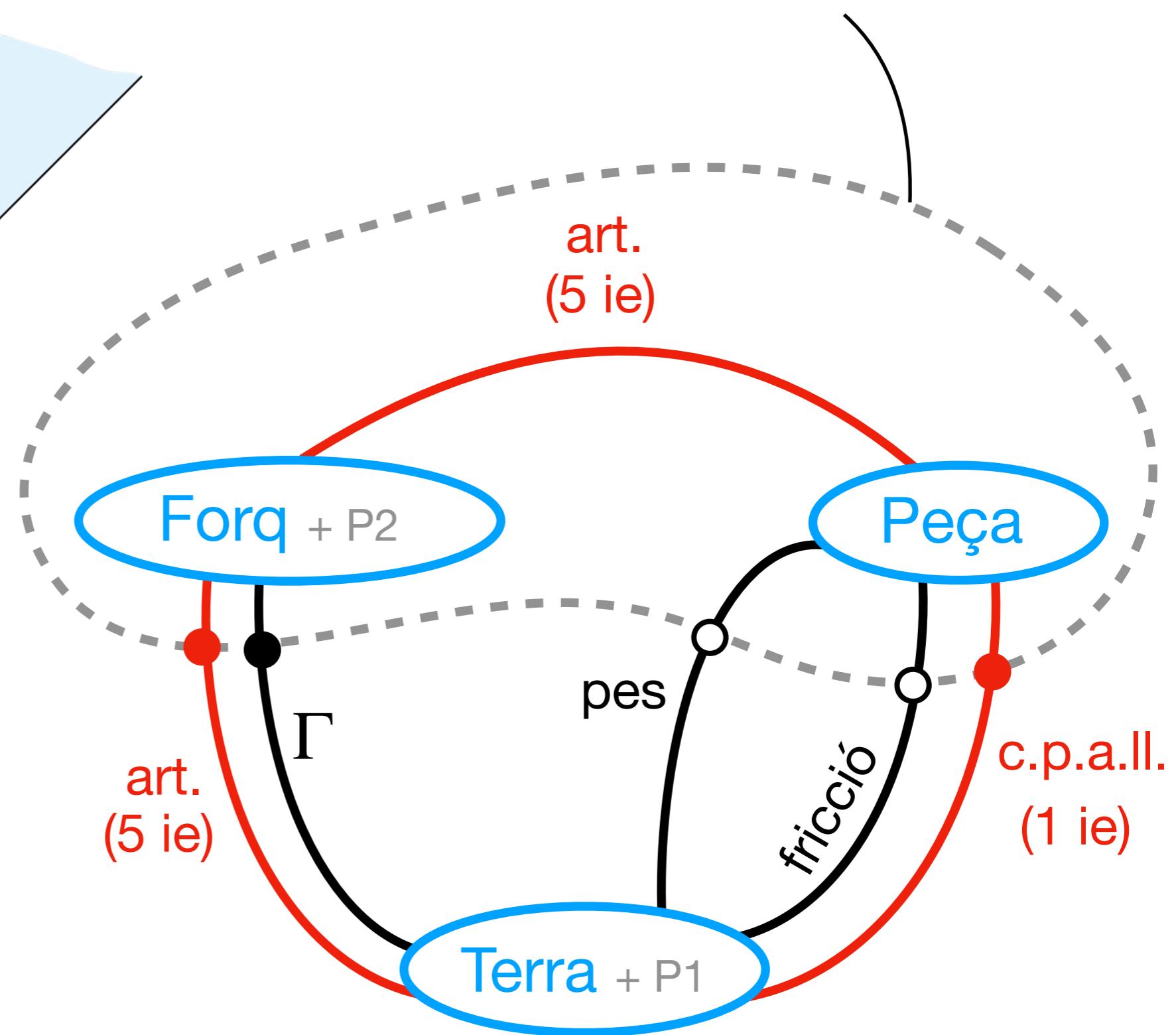


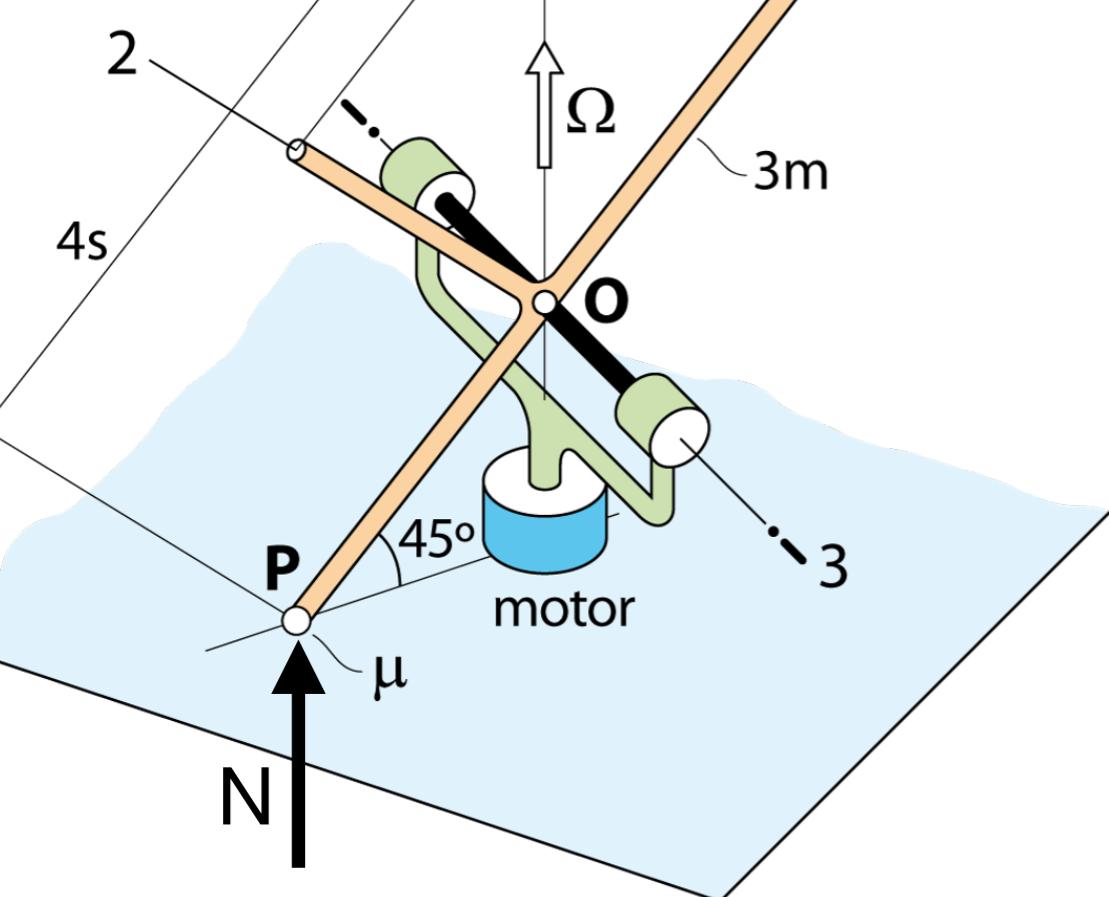
Volem N  $\Rightarrow$  SIST ha d'incloure la peça!



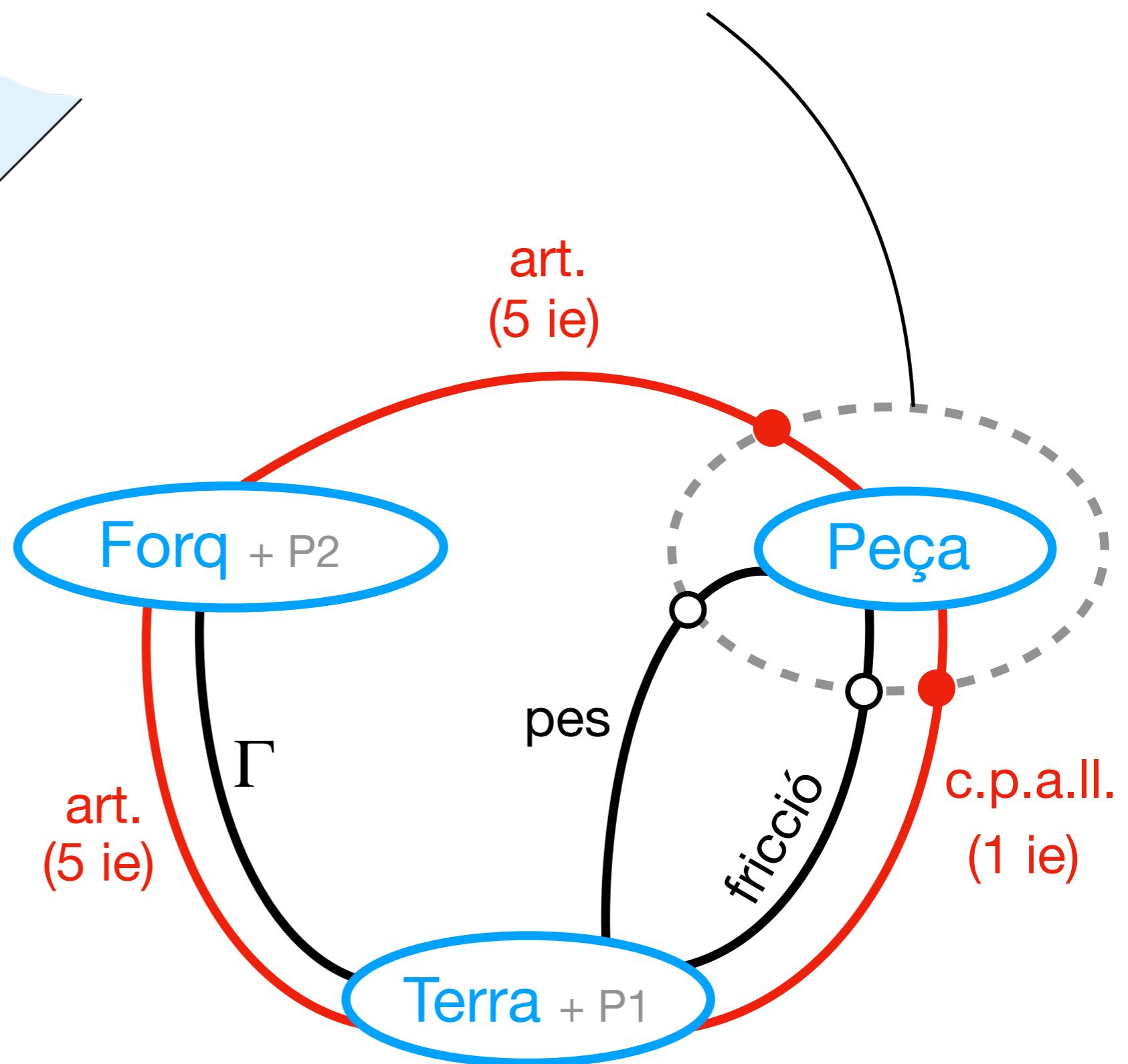


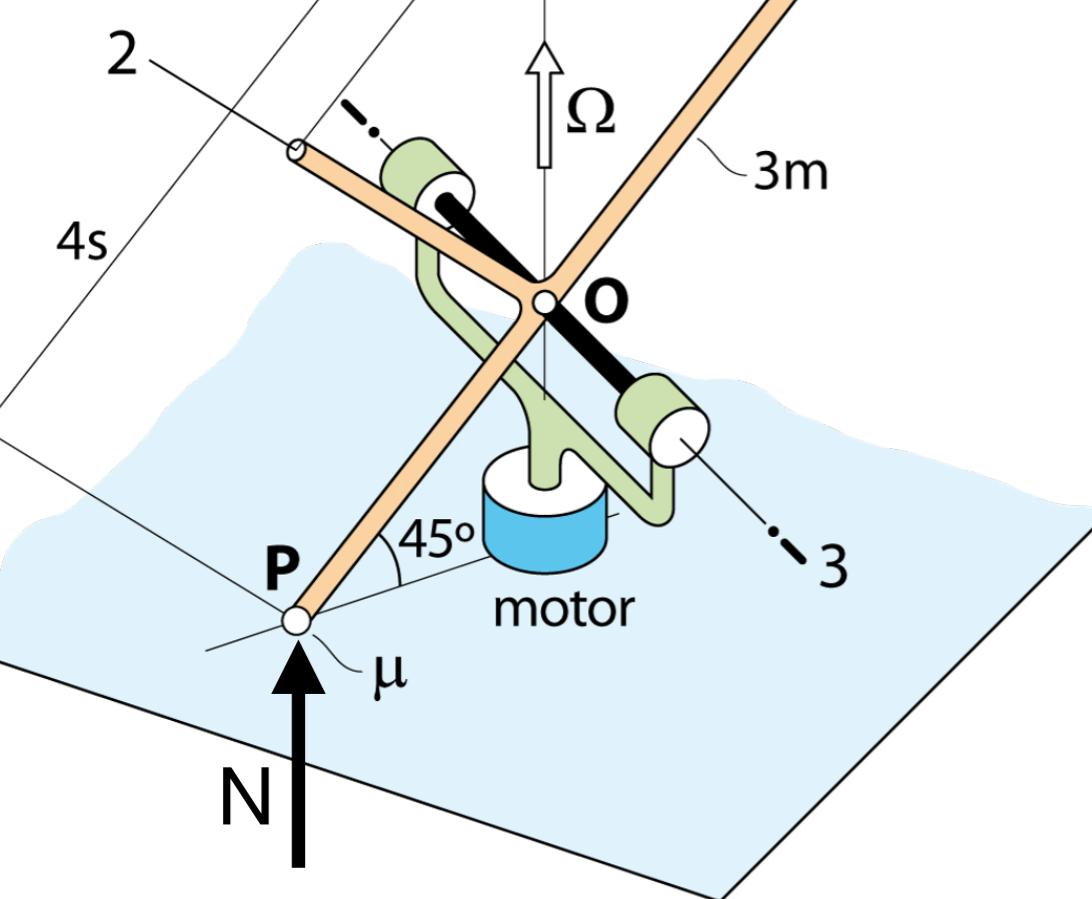
$6 \text{ ie} + \Gamma \Rightarrow \text{INDETERMINAT}$





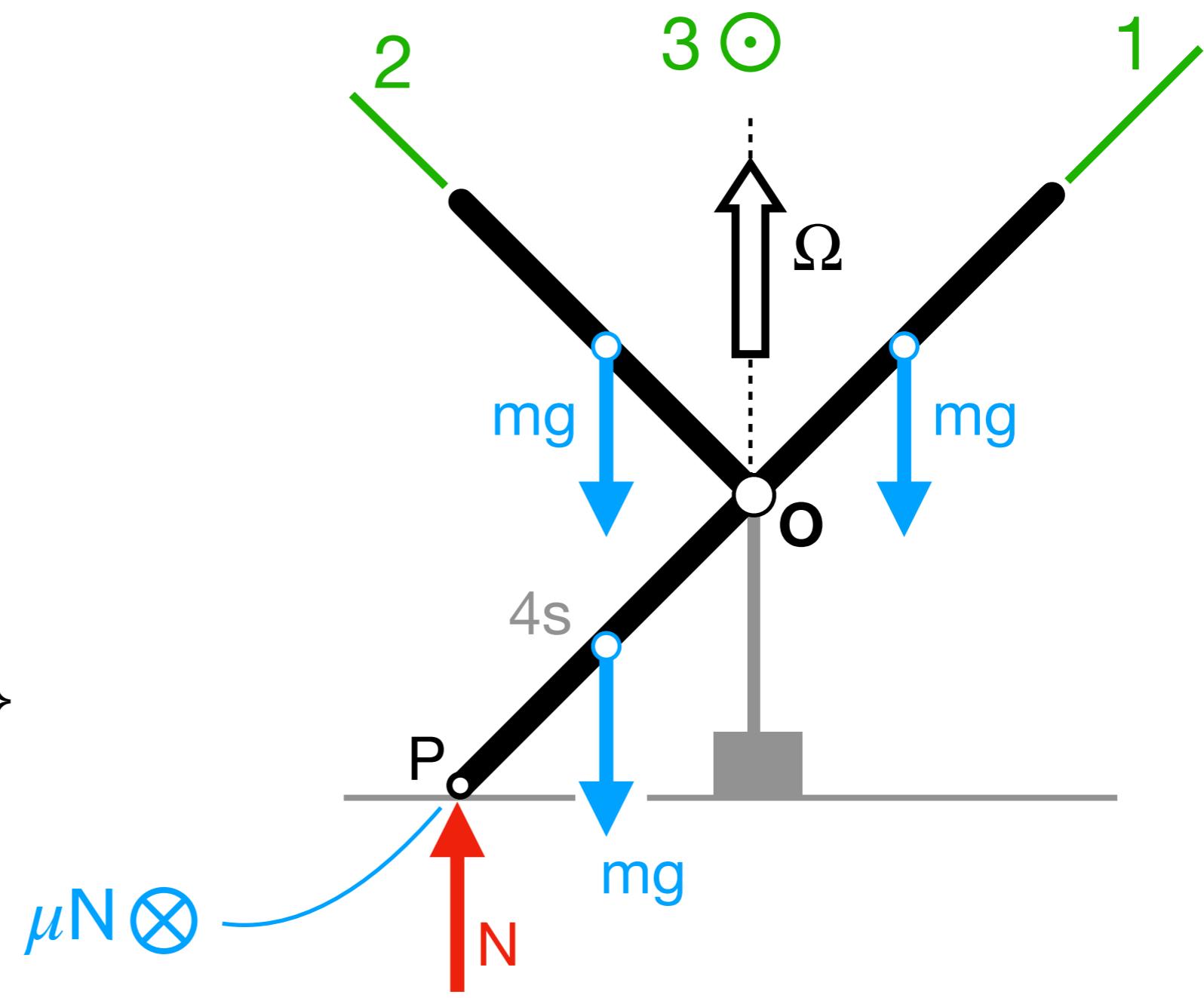
6 ie  $\Rightarrow$  DETERMINAT





$$\left\{ \bar{F}_{\text{Forq} \rightarrow \text{Peça}} \right\}_B = \begin{Bmatrix} F_1 \\ F_2 \\ F_3 \end{Bmatrix}$$

$$\left\{ \bar{M}_{\text{Forq} \rightarrow \text{Peça}} (O) \right\}_B = \begin{Bmatrix} M_1 \\ M_2 \\ 0 \end{Bmatrix}$$



## DEURES

Determineu

- Parell motor  $\Gamma$  per mantenir  $\Omega = ct$
- Eq. mov. per al cas en que el contacte a P ja s'ha perdut ( $\Omega > \Omega_{\text{critica}}$ )