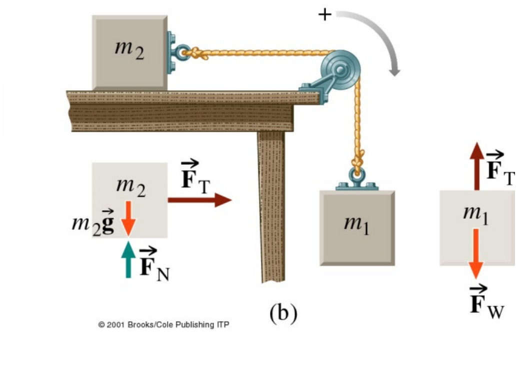
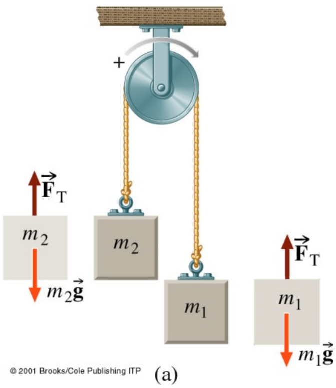
ÉQUILIBRE

PGC-04

(PGC-02)

RAPPEL – MOUVEMENT COUPLÉ





$\downarrow \vec{a}$

$\vec{F}_W = \vec{F}_T$

Au repos

$m_1 > m_2$

$F_{W_1} > F_T$

$a_1 = a_2$

ÉQUILIBRE STATIQUE

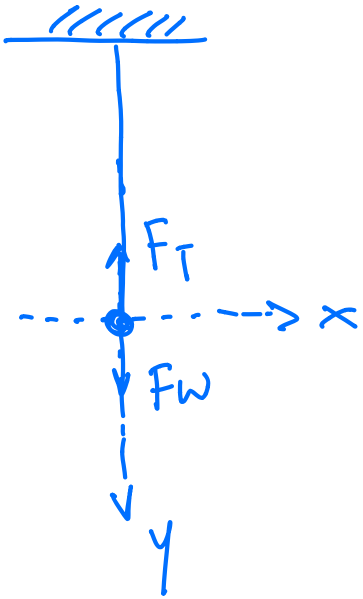
$$\Sigma \vec{F} = 0 \iff \vec{v} = \text{const}$$

$$\Sigma \vec{F}_x = 0$$

$$\Sigma \vec{F}_y = 0$$

$$F_T = F_W$$

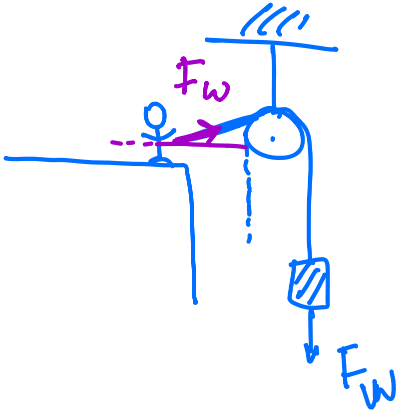
Sans Rotation.



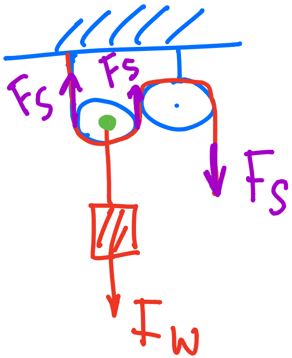
SYSTÈMES DE FORCES PARALLELES

Poulies

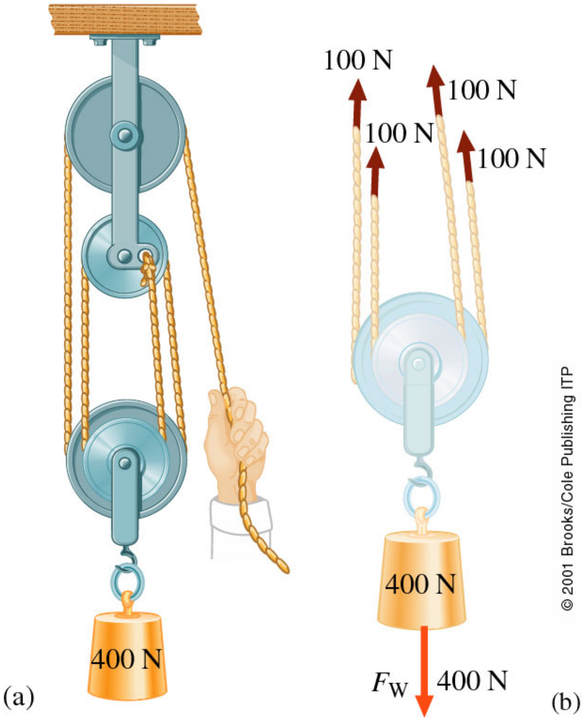
- Reorienter forces

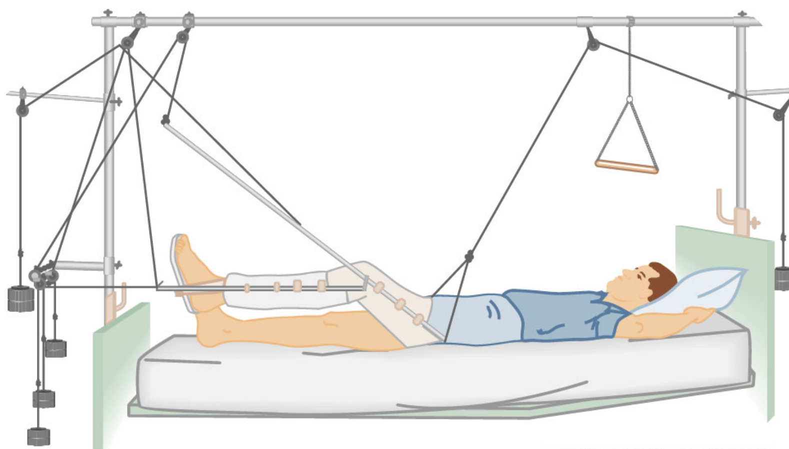


- Demultiplier forces



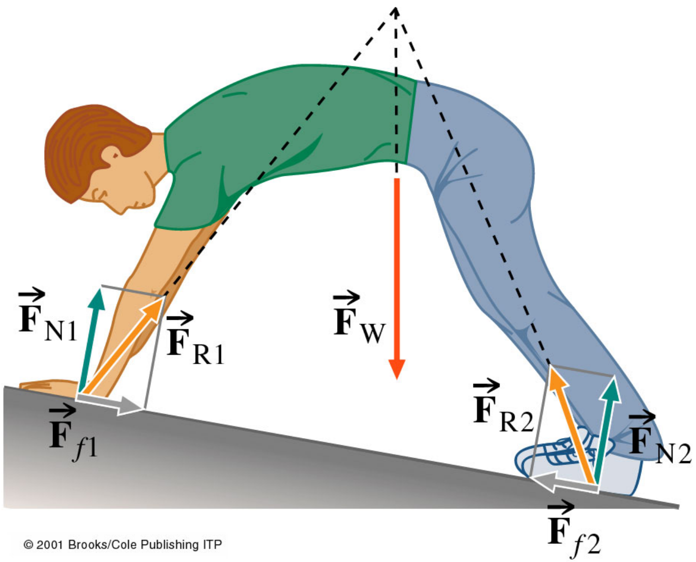
$$F_s = \frac{1}{2} F_w$$


100 N
100 N
100 N
100 N
400 N
400 N
F_W 400 N
(a)
(b)



FORCES CONCOURANTES

$$\sum \vec{F} = \vec{F}_W + \vec{F}_{R1} + \vec{F}_{R2} =$$

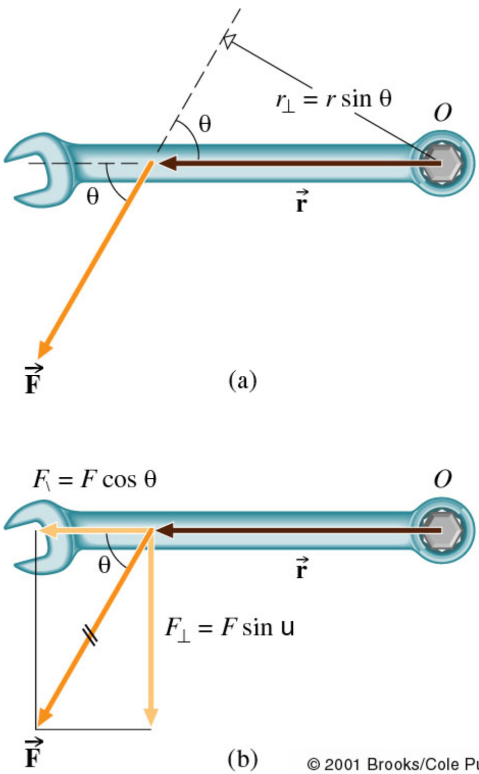


LE MOMENT DE FORCE

$$\tau_O = r_\perp \cdot F = r \cdot \sin\theta \cdot F =$$
$$= r \cdot F \cdot \sin\theta =$$
$$= r \cdot F_\perp$$

bras de levier

$$[\tau] = [F] \cdot [r] = N \cdot m$$

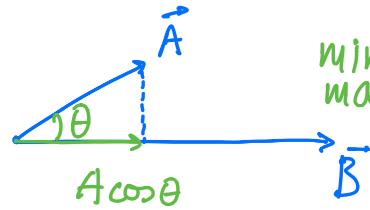


Produit Scalaire

$$\vec{A} = \begin{pmatrix} A_x \\ A_y \end{pmatrix}$$

$$\vec{B} = \begin{pmatrix} B_x \\ B_y \end{pmatrix}$$

$$\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y =$$
$$= |A| \cdot |B| \cdot \cos\theta$$



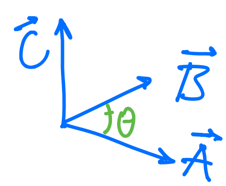
min $\theta = 90°$
max $\theta = 0°$

Produit Vectoriel

$$\vec{C} = \vec{A} \times \vec{B}$$

$$\begin{pmatrix} C_x \\ C_y \\ C_z \end{pmatrix} = \begin{pmatrix} A_x \\ A_y \\ \cancel{A_z} \end{pmatrix} \times \begin{pmatrix} B_x \\ B_y \\ \cancel{B_z} \end{pmatrix} = \begin{pmatrix} A_y \cancel{B_z} - \cancel{A_z} B_y \\ -(A_x \cdot \cancel{B_z} - \cancel{A_z} B_x) \\ A_x B_y - A_y B_x \end{pmatrix}$$

$$|\vec{C}| = |\vec{A}| \cdot |\vec{B}| \cdot \sin\theta$$



min $\theta = 0$
max $\theta = 90°$

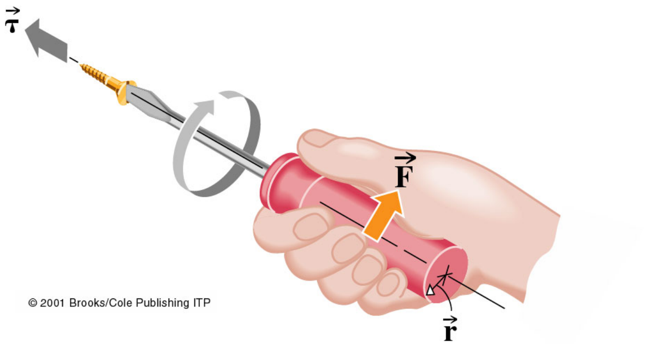
Si $A = \begin{pmatrix} A_x \\ A_y \\ 0 \end{pmatrix}$ $\quad B = \begin{pmatrix} B_x \\ B_y \\ 0 \end{pmatrix}$ $\Rightarrow$ $C = \begin{pmatrix} 0 \\ 0 \\ C_z \end{pmatrix}$

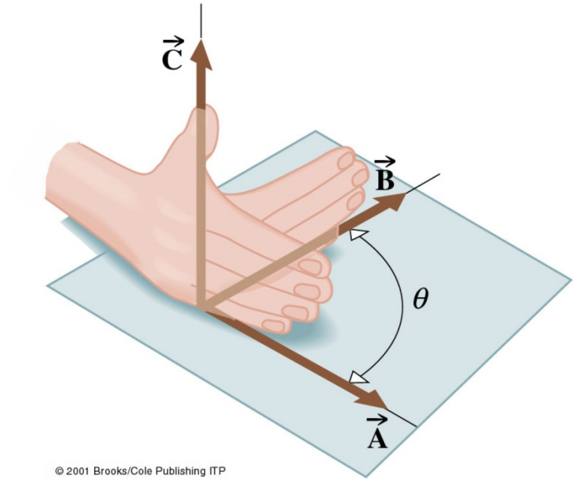
$A_z = 0 \qquad B_z = 0$

LE MOMENT DE FORCE

$$\tau_o = rF\sin\theta$$

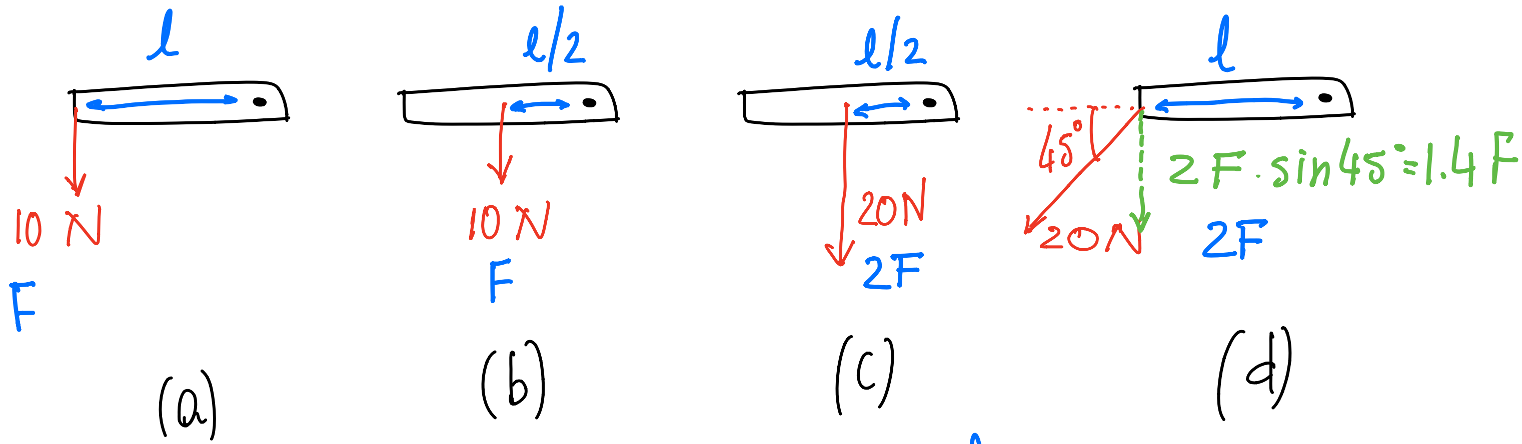
$$\vec{\tau}_o = \vec{r} \times \vec{F}$$





QUESTION

Dans quelle situation le moment de force est-il plus grand?



$\tau = F \cdot \ell$

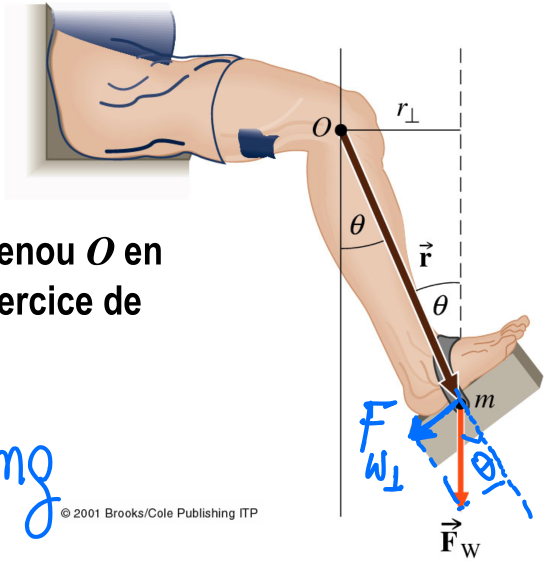
$\tau = F \cdot \frac{\ell}{2}$

$\tau = 2F \cdot \frac{\ell}{2} = F \cdot \ell$

$\tau = 1.4\,F \cdot \ell$

$$\vec{\tau}_o = \vec{r} \times \vec{F}$$

EXEMPLE



QUESTION: Exprimez le moment des forces par rapport au genou *O* en fonction de θ, *m*, et la distance *r* du genou au talon dans l'exercice de musculation ci-contre. Négligez la masse de la jambe.

$$\tau_o = r_\perp \cdot F_W = r_\perp \cdot mg = r \cdot \sin\theta \cdot mg$$

τ_o min $\theta = 0$

τ_o max $\theta = 90°$

SECONDE CONDITION D'ÉQUILIBRE

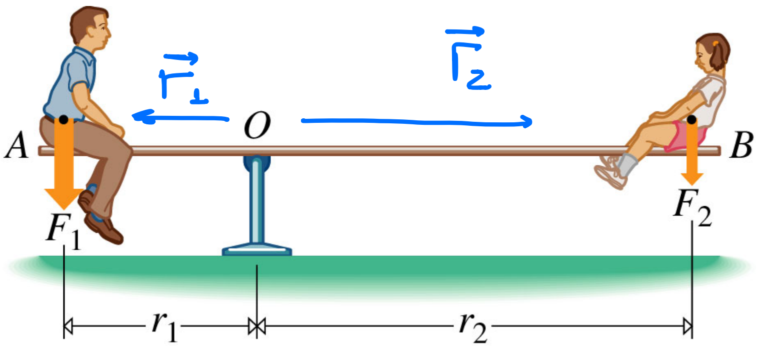
$\vec{\tau} = \vec{r} \times \vec{F}$ $\quad \Sigma \vec{F} = 0 \Leftrightarrow \Delta \vec{v} = 0 \quad , \vec{v} = \text{const}$

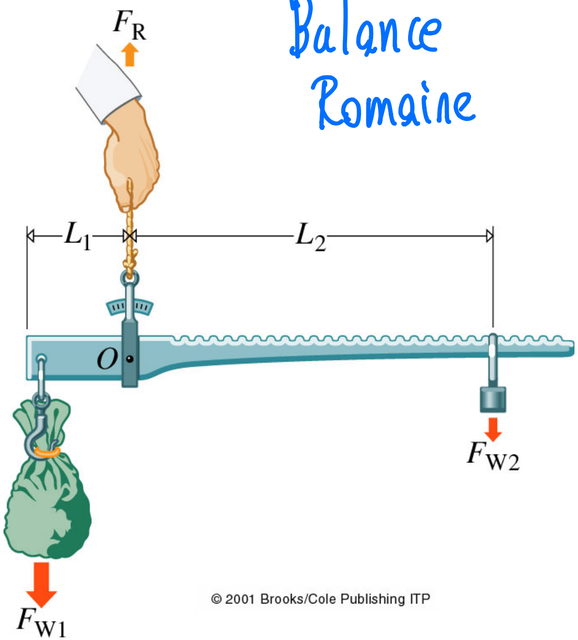
$$\Sigma \vec{\tau} = 0 \Leftrightarrow \Delta \vec{\omega} = 0$$

Balance Romaine

$F_1 > F_2 \quad \Sigma \vec{F} = \vec{F}_1 + \vec{F}_2 \neq 0$

$$F_1 \cdot r_1 = F_2 \cdot r_2$$





QUESTION

Quelle est l'indication de la balance?

$F_B = ?$

a) 200 N

b) 400 N

c) 100 N

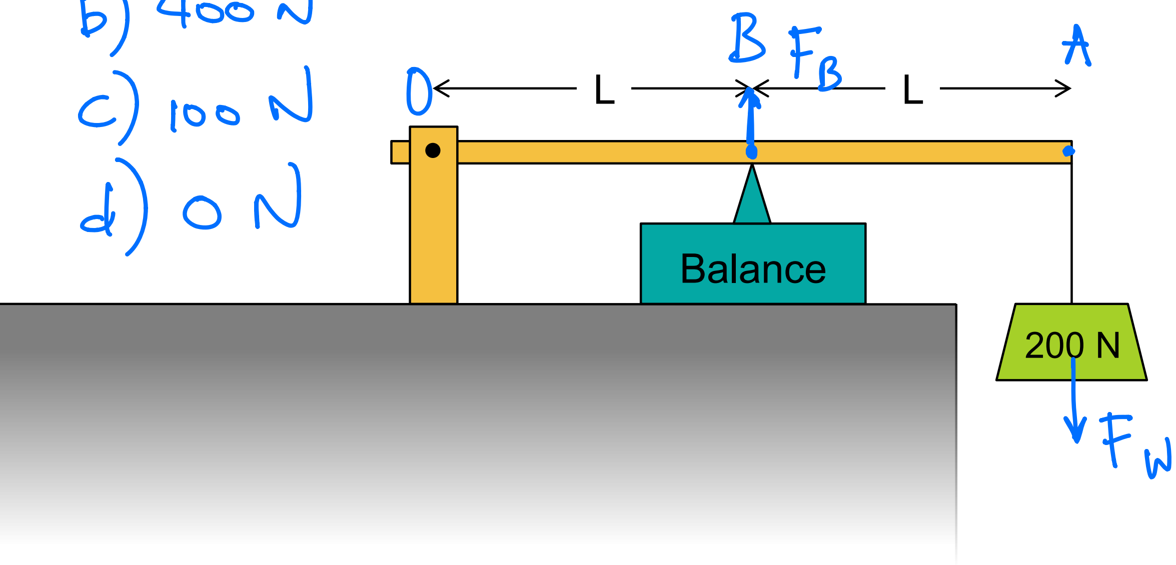
d) 0 N

$\sum \vec{\tau} = 0$

$-\vec{\tau}_{AO} = \vec{\tau}_{BO}$

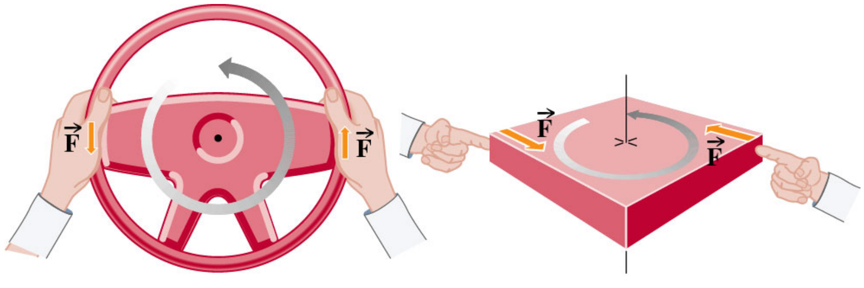
$F_W \cdot 2L = F_B \cdot L$

$\Rightarrow \quad F_B = 2F_W$



FORCES NON-CONCOURANTES

$\Sigma \vec{F} = 0$ $\quad$ MAIS $\quad$ $\Sigma \vec{\tau} \neq 0$



(a) (b)

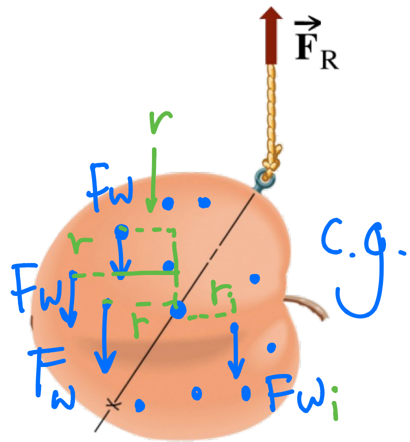
CENTRE DE MASSE

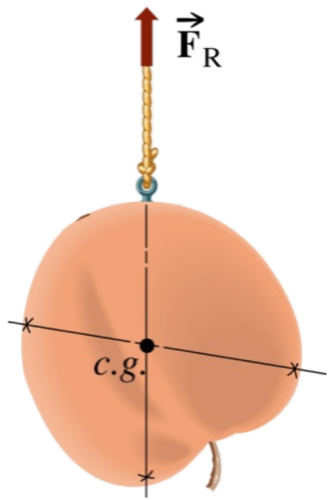
$\Sigma F_{w_i} r_i$

$$x_{c.g.} = \frac{\sum_{i=1}^{N} F_{w_i} r_i}{\sum_{i=1}^{N} F_{w_i}}$$

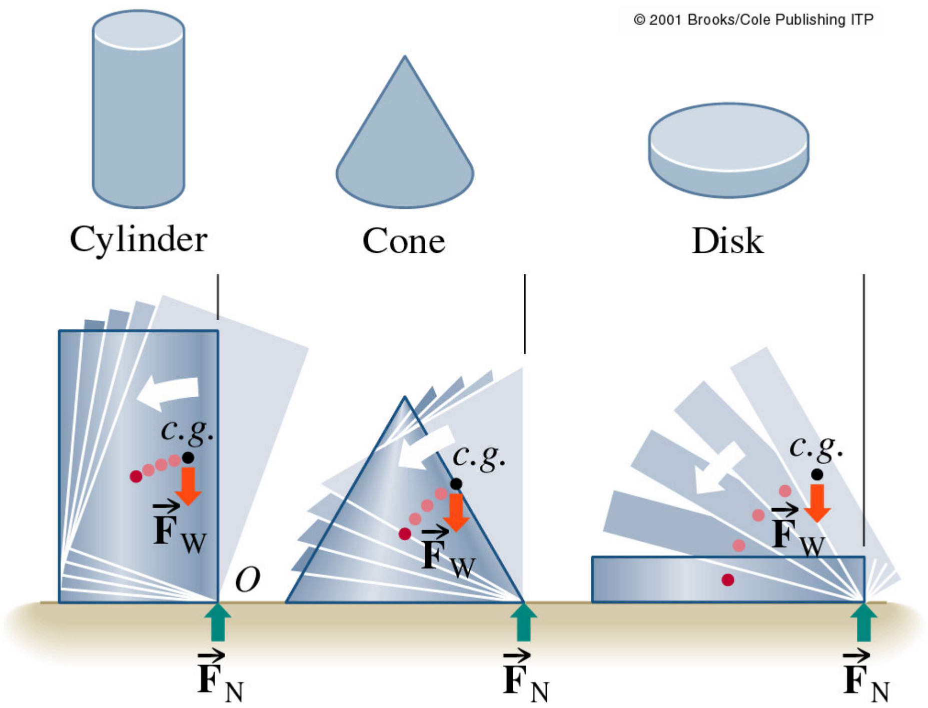
$$\sum F_{w_i} \cdot x_{cg} = \sum_{i=1}^{N} F_{w_i} r_i$$

$$F_w \cdot x_{cg} = \sum_{i=1}^{N} F_{w_i} r_i$$





STABILITÉ ET ÉQUILIBRE

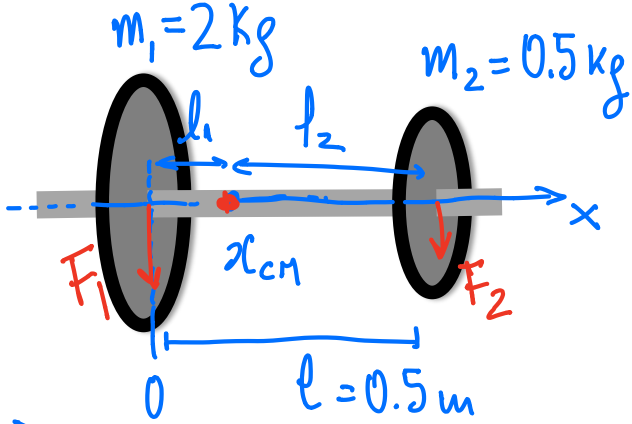


LE CENTRE DE MASSE

Un haltère se compose d'un disque de 500 gr d'une coté et d'un disque de 2 kg de l'autre coté. On considère la barre qui les connecte sans masse et le longueur 50 cm. Calculer le centre de masse.

$$F_1 \cdot l_1 = l_2 \cdot F_2$$

$$x_{CM} = \frac{\sum_i F_i x_i}{\sum F_i} \qquad F_i = m_i g$$



$$x_{CM} = \frac{F_1 \cdot x_1 + F_2 \cdot x_2}{F_1 + F_2} =$$

$$= \frac{m_1 \cdot \cancel{x_1} + m_2 \cdot x_2}{m_1 + m_2} = \frac{m_2 \cdot l}{m_1 + m_2} \Rightarrow$$

$$x_{CM} = \frac{m_2 \, l}{m_1 + m_2} = \dots 0{,}1 \, m$$

LE CENTRE DE MASSE - QUESTION

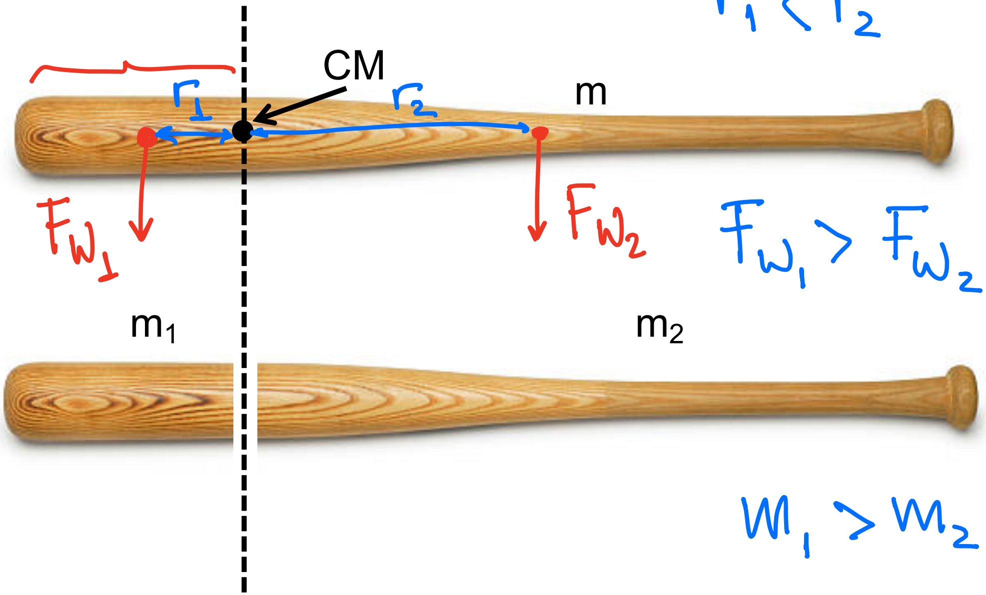
$$\sum \vec{\tau}_{CM} = 0 \Rightarrow F_{W_1} \cdot r_1 = F_{W_2} \cdot r_2$$

$$r_1 < r_2$$

(a) $m_1 > m_2$

(b) $m_1 = m_2$

(c) $m_1 < m_2$



$$F_{W_1} > F_{W_2}$$

$$m_1 > m_2$$