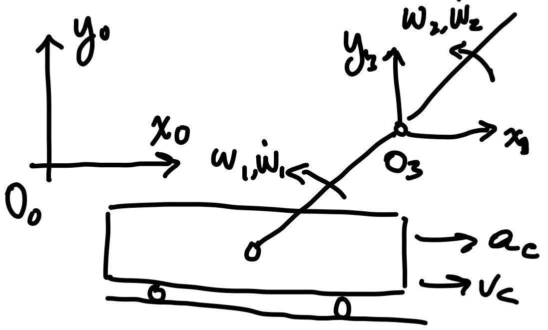
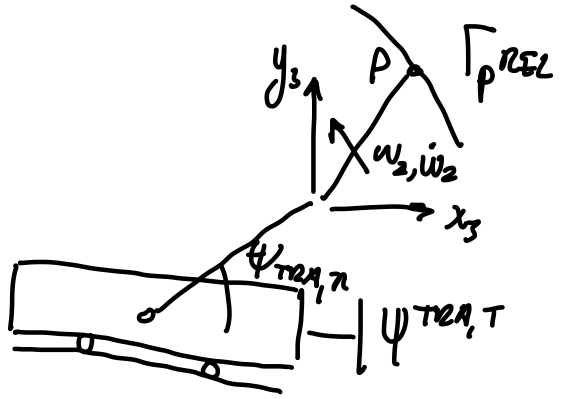
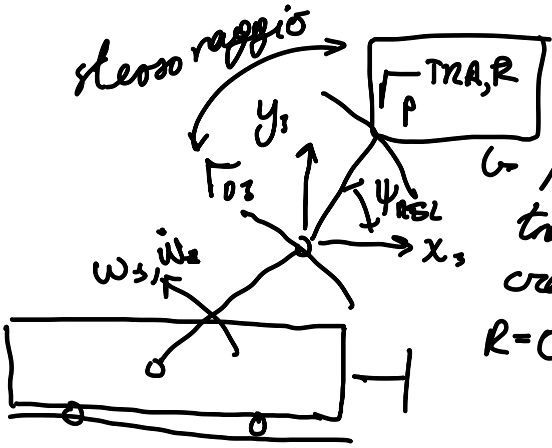
# Esercitazione 5 -

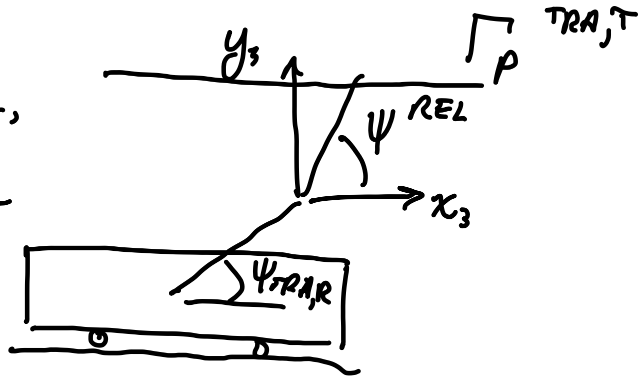
## Sistema Traslante



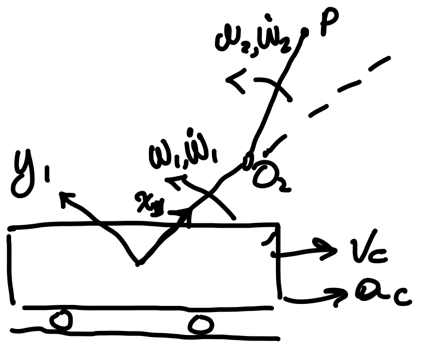



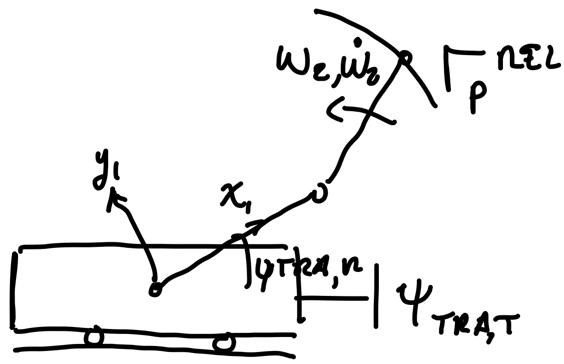



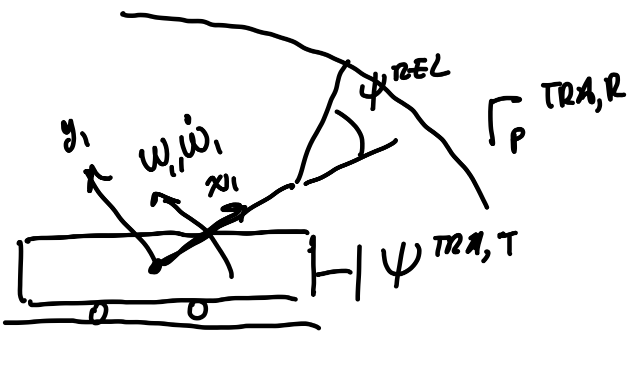

→ Non nota, traslate, crea raggio $R = O_3 - O_1$

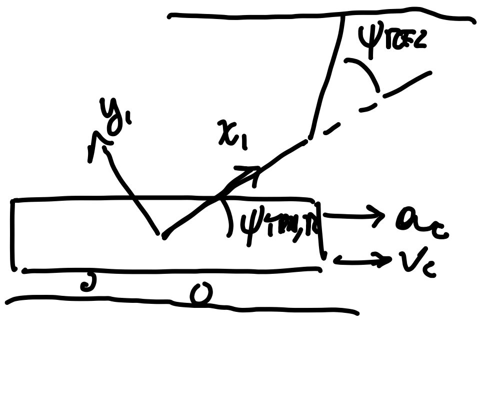



## Sistema diverso, rotante mobile



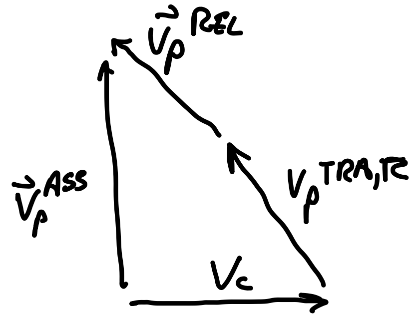



$$\vec{V}_p^{ASS} = \vec{V}_p^{TRA,T} + \vec{V}_p^{TRA,T} + \vec{V}_p^{REL}$$

| | | | | |
|---|---|---|---|---|
| M | ? | $v_c$ | $\omega_1 O_1O_3$ | $\omega_2 O_2P$ |
| D | ? | ORIZZ | $\perp O_1O_3$ | $\perp O_2P$ |

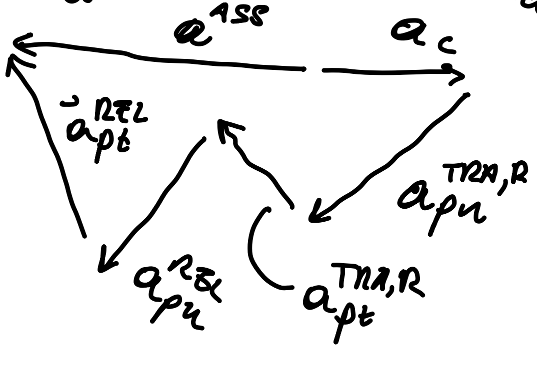



$$\vec{a}_p^{ASS} = \vec{a}_p^{TRA} + \vec{a}_p^{REL} + \vec{a}_p^{COR}$$

$$\vec{a}_p^{ASS} = \vec{a}_{pn}^{TRA,T} + \vec{a}_{pt}^{TRA,T} + \vec{a}_{pn}^{TRA,R} + \vec{a}_{pt}^{TRA,R} + \vec{a}_{pn}^{REL} + \vec{a}_{pt}^{REL} + a_p^{CO}$$

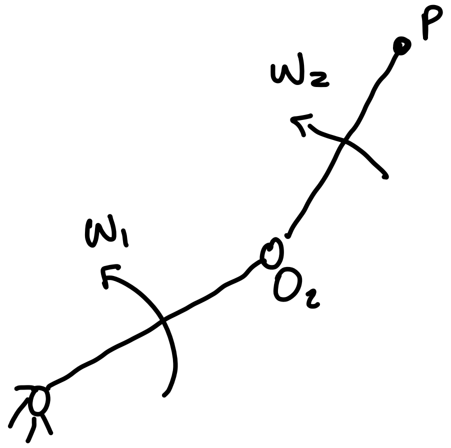
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| M | ? | =0 X perchè $\Gamma_p^{TRA,T}$ | $a_c$ | $\omega_1^2 \cdot O_1O_3$ | $\dot{\omega}_1 O_1O_3$ | $\omega_2^2 O_3P$ | $\dot{\omega}_2 O_3P$ | =0 |
| D | ? | X è rettilinea | ORIZZ | $// O_1O_2$ $O_3 \to O_1$ | $\perp O_1O_3$ | $// O_3P$ $P \to O$ | $\perp O_3P$ | Perchè rif $O_3, x_3 y_3$ è traslante, non gira quindi non può esser generato coriolis |

$O_1, O_2$ perchè i vettori sono generati lì e poi li spostiamo indietro




la traiettoria che voglio è quella rosso, poi quella blu è usata per trovare i valori, perchè quella è quella dove la deriviamo

# Esempio numerico



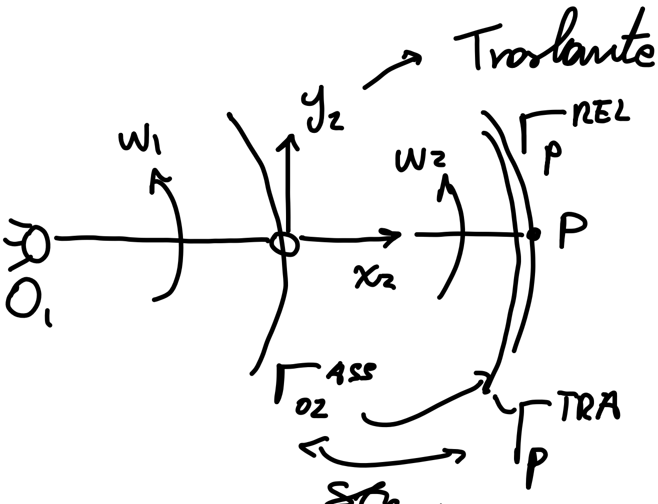

$\omega_1 = 5 \frac{rad}{s}$ $\qquad \dot\omega_1 = \dot\omega_2 = 0$

$\omega_2 = 2 \frac{rad}{s}$

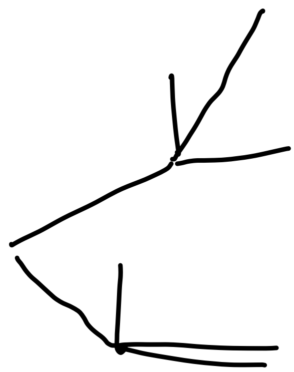
$L_1 = 1{,}0$

$L_2 = 0{,}5$

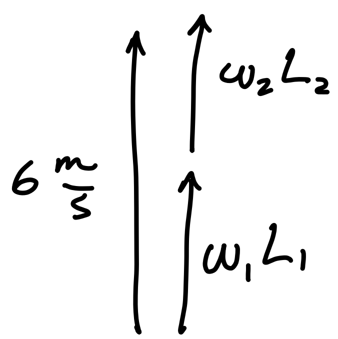
# Facciamo una cosa più furba




Stesso raggio
per sistema traslante



| | | |
|---|---|---|
| $\vec{v}_P^{ASS} =$ | $\vec{v}_P^{REL}$ | $\vec{v}_P^{TRA}$ |
| ? | $\omega_2 L_2$ | $\omega_1 L_1$ |
| ? | $\perp O_1O_2$ | $\perp O_2P$ |

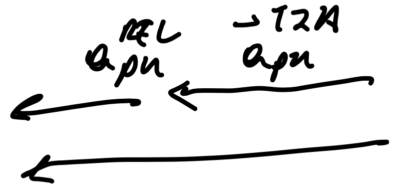


$a_p^{ABS}$ $\vec{a}_{pn}^{TRA}$ $a_{pt}^{TRA}$ $\quad$ $a_{pt}^{REL}$ $a_{pn}^{REL}$ $a_p^{CO}$

? $\omega_1^2 L_1$ $\dot{\omega}_1 = 0$ $\quad$ $\omega_2^2 O_2P$ $\dot{\omega}_2 = 0$ $= 0$

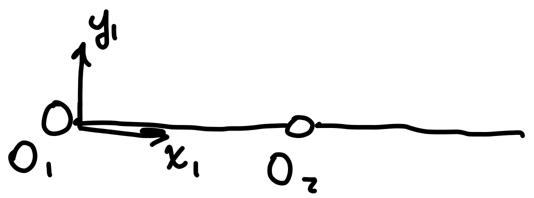
? $// O_1O_2$ X $\quad$ $// O_2P$ X

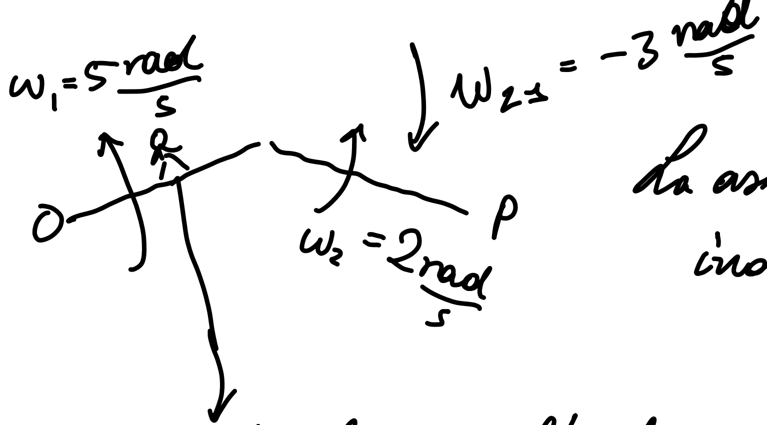
Rende Riferimento traslante




$27 \frac{m}{s^2}$

Sistema rotante

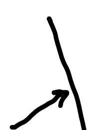


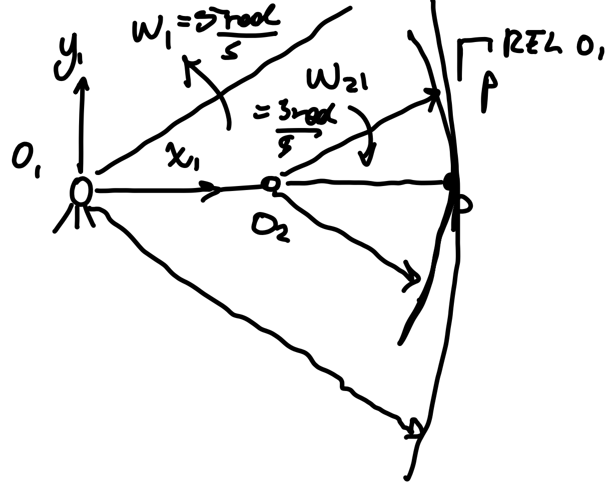




La asta 2 rimane indietro

Rispetto al omino l'asta 2 ruote relativamente a $-3 \frac{rad}{s}$

Questa è la velocità relativa degli oggetti

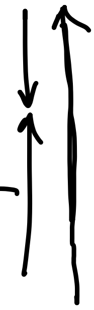





| | $\vec{V}_p^{\,ASS}$ | $\vec{V}_p^{\,TRA}$ | $\vec{V}_p^{\,REL}$ |
|---|---|---|---|
| M | ? | $\omega_1(L_1+L_2)$ | $\omega_{21} L_2$ |
| D | ? | $\perp O_1P$ | $\perp O_2P$ |

$\vec{V}_p^{\,REL} = \omega_{21} L_2 = 1,5\ m/s$

$\vec{V}_p^{\,TRA} = \omega_1(L_1+L_2) = 7,5\ m/s$



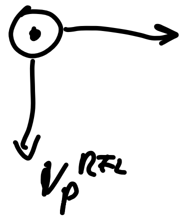
$V^{ASS} = 6\ \frac{m}{s}$

Stessa velocità

$$\vec{a}_p^{\,ASS} = \vec{a}_{pn}^{\,TRA} + \vec{a}_{pt}^{\,TRA} + \vec{a}_{pn}^{\,REL} + \vec{a}_{pt}^{\,REL} + \vec{a}_p^{\,CO}$$

$15\ \frac{m}{s^2}$

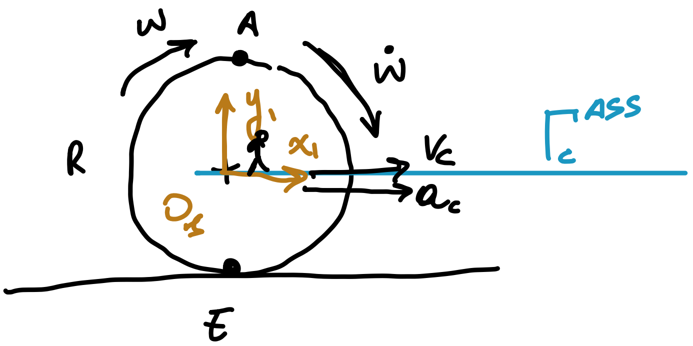
| | $\vec{a}_p^{\,ASS}$ | $\vec{a}_{pn}^{\,TRA}$ | $\vec{a}_{pt}^{\,TRA}$ | $\vec{a}_{pn}^{\,REL}$ | $\vec{a}_{pt}^{\,REL}$ | $\vec{a}_p^{\,CO}$ |
|---|---|---|---|---|---|---|
| M | ? | $\omega_1^2(L_1+L_2)$ | $\dot{\omega}_1 = 0$ | $\omega_{21}^2 L_2$ | $\dot{\omega}_{21} = 0$ | $2\omega_1 \omega_{21} L_2$ |
| D | ? | $// O_1P$ | X | $// O_2P$ | X | $// O_2P$ <br> $O_2 \to P$ |




$\vec{a}_p^{\,\infty} = 15\,\frac{m}{s^2}$ $\qquad$ $\vec{a}_p^{\,ASS} = 27\,\frac{m}{s^2}$

La velocità assoluta è uguale ma in questo caso dobbiamo tenere a conto la accelerazione di Coriolis

## Rotolamento



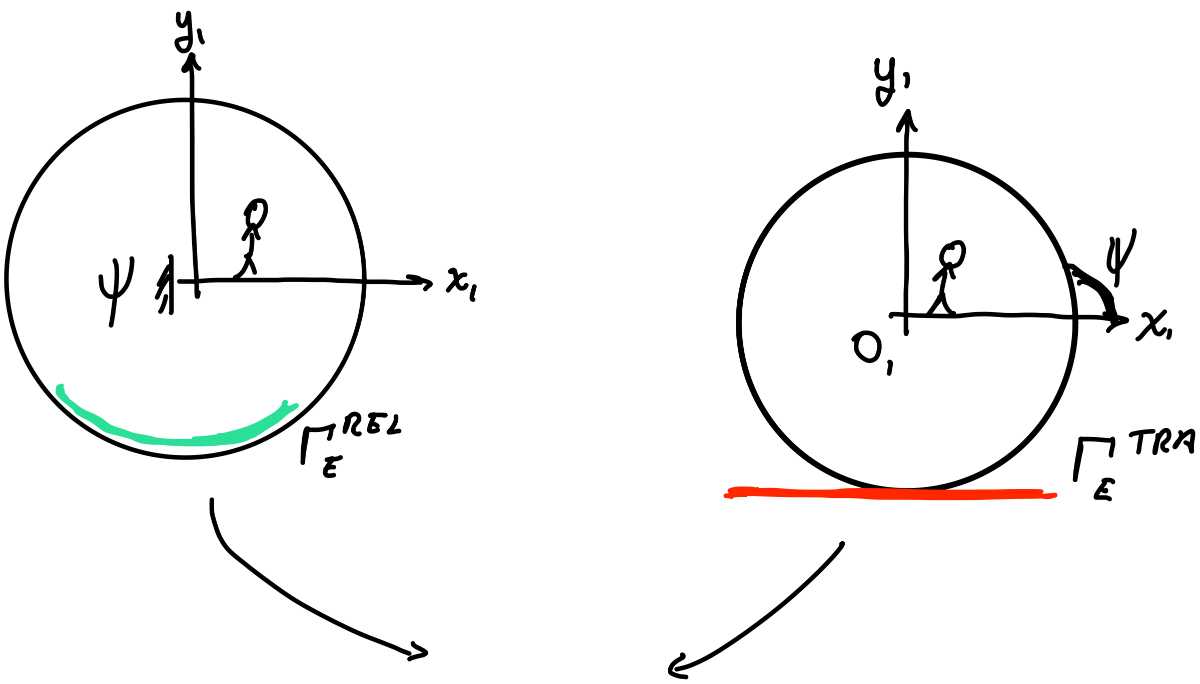

$V_c = \omega R \qquad a_c = \dot{\omega} R$

Rif. $O_1, x_1, y_1$ traslante

con $C \equiv O_1$

$v_E, V_p$ ?

$a_E, a_p$ ?




Punto E è fermo, quindi la combinazione ci deve portare ad esser fermo

$$\vec V_E^{ASS} = \vec V_E^{REL} + \vec V^{TRA}$$

| | | | |
|---|---|---|---|
| M | ? | $\omega R$ | $v_c = \omega R$ |
| D | ? | $\perp CE$ | ORIZZ |

$\vec V_E^{REL}$

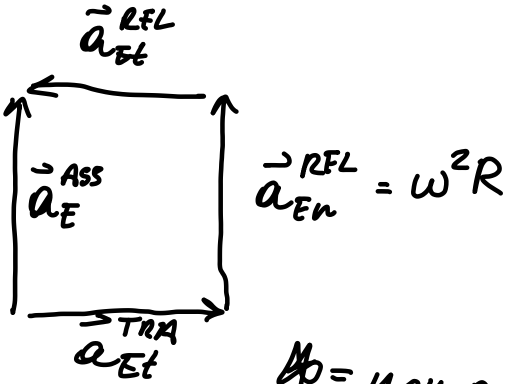
$V_E^{TRA} = \omega R \ (= v_c)$

$V_E = 0$

Non deve strisciare deve solo appoggiare

$$\vec a_E^{ASS} = \vec a_{En}^{TRA} + \vec a_{Et}^{TRA} + \vec a_{En}^{REL} + \vec a_{Et}^{REL}$$

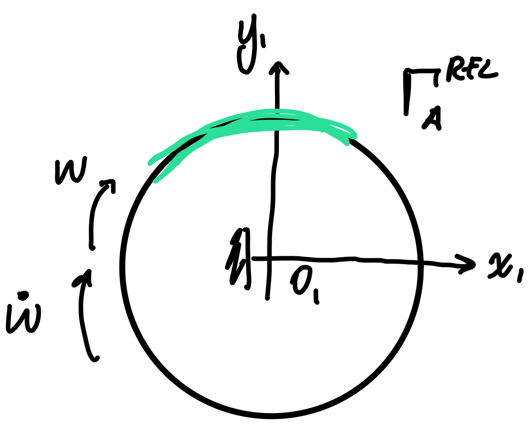
| | | | | | |
|---|---|---|---|---|---|
| M | ? | $= 0$ perché | $a_c (= \dot\omega R)$ | $\omega^2 R$ | $\dot\omega R$ |
| D | ? | $\Gamma_E^{TRA}$ rettilineo | ORIZZ | $//CE$ $E \to C$ | $\perp CE$ |

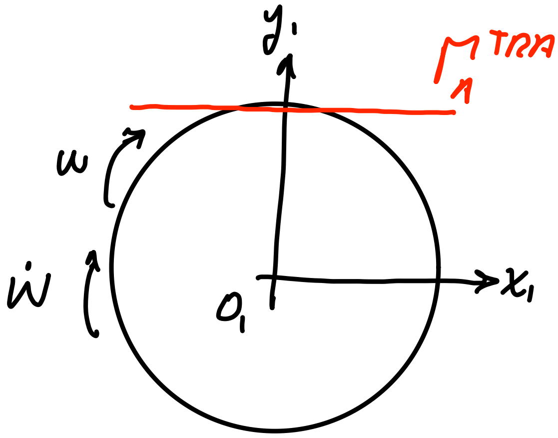



~~$a_b$~~ = non può avere neanche

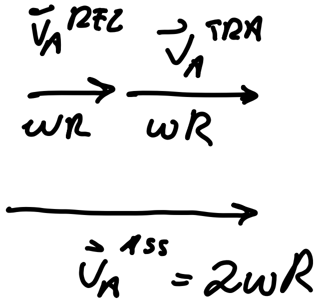
se $\vec a^{ASS}$ rimarrebbe lì; $\vec a_t \neq 0$ perché striscerebbe nel prossimo istante

## Punto A

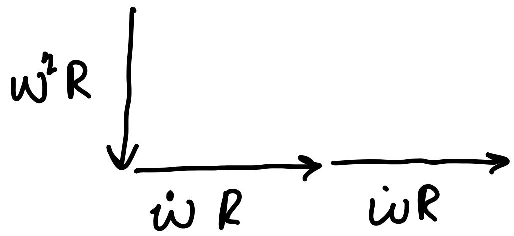


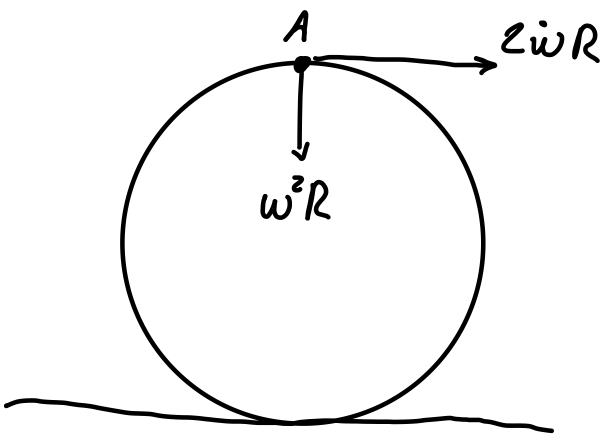



| | $\vec{v}_A^{ASS}$ | = | $\vec{v}_A^{REL}$ | + | $\vec{v}_A^{TRA}$ |
|---|---|---|---|---|---|
| M | ? | | $\omega R$ | | $v_c = \omega R$ |
| D | ? | | $\perp O_2A$ | | ORIZZ |

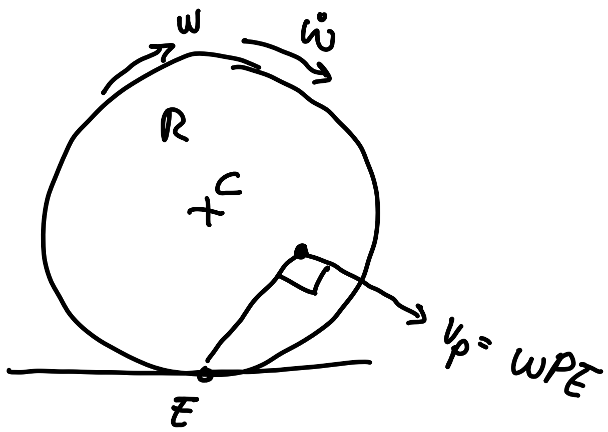


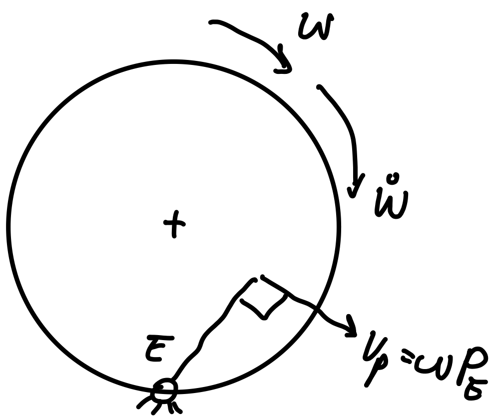

| | $\vec{a}_A^{ASS}$ | = | $\vec{a}_{An}^{REL}$ | + | $\vec{a}_{At}^{REL}$ | + | $\vec{a}_{An}^{TRA}$ | + | $\vec{a}_{At}^{TRA}$ |
|---|---|---|---|---|---|---|---|---|---|
| M | ? | | $\omega^2 R$ | | $\dot{\omega} R$ | | $=0$ perché rettilineo | | $a_c = \omega R$ |
| D | ? | | $/\!/ AC$ | | $\perp AC$ | | | | ORIZZ. |




Il punto E è CIR



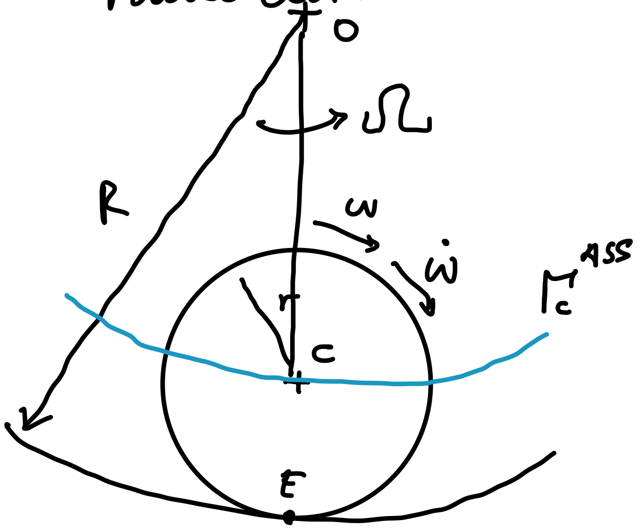
$a_E = \omega^2 R$ $\qquad\qquad$ $a_E = 0$

I due sistemi sono identici <u>per le velocità</u>

Ma le accelerazioni vanno vedere la differenza tra il vincolo di contatto e cerniera.

Le accelerazioni ci rivelano che i sistemi non sono uguali: sistemi uguali hanno accelerazioni uguali

Piano curvilineo




$v_c = \omega r$

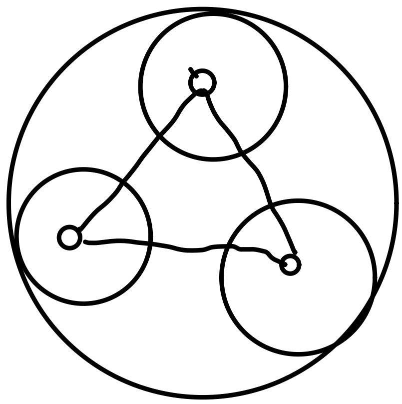
$a_{ct} = \dot{\omega} r$

$a_{cn} = \dfrac{v_c^2}{R-r} = \omega^2 \dfrac{r^2}{R-r}$

$$\Omega = \omega \frac{r}{R-r} \Rightarrow \Omega (R-r) = \omega r$$

$$\dot{\Omega}(R-r) = \dot{\omega} r \qquad \dot{\Omega} = \dot{\omega} \frac{r}{R-r}$$

Questo può esser utilizzato per studiare i cambi planetari:



Possiamo studiare i riduttori di velocità come quello qui.