Rotational Dynamics

Wednesday, August 5, 2020 9:51 AM

Angular Velocity

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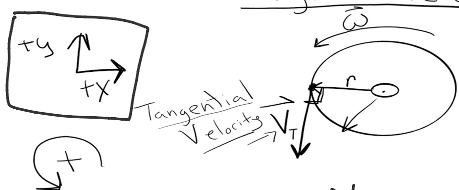
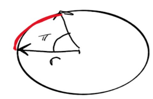


$\vec{V}_T = \vec{\omega} \cdot r$

$m/s = \frac{\cancel{rad}}{s} \cdot \frac{m}{\cancel{rad}}$

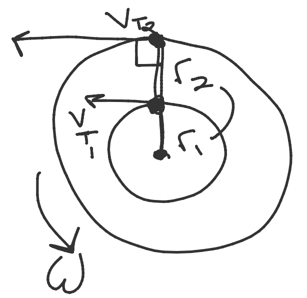
$= 1/s \cdot m/1$

Note: A radian is a unitless quantity
It defines the angle to rotate a circle
to get 1 radius of arc length.



$C = \pi D$

$C = 2r\pi$

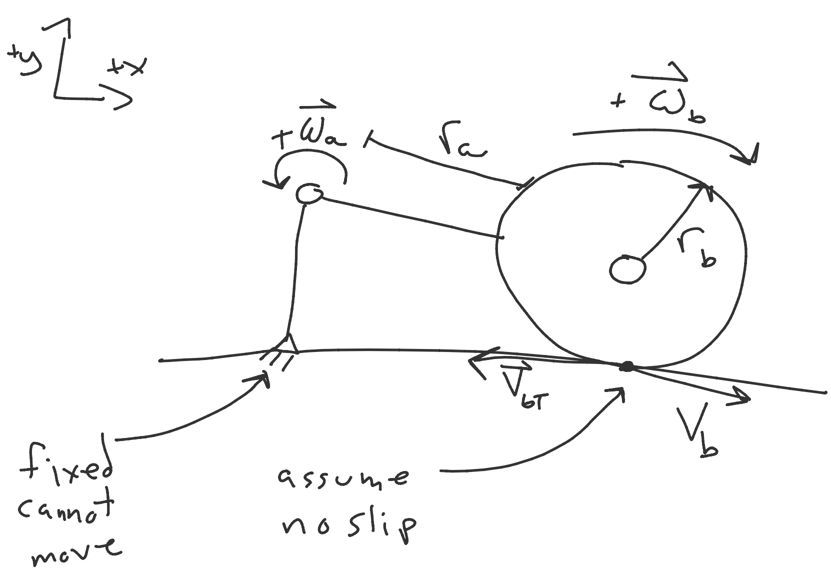


$r_2 = 2r_1$

$$\frac{V_{T_2} = \omega r_2}{V_{T_1} = \omega r_1} = \omega 2 r_1$$

$$\frac{V_{T_2}}{V_{T_1}} = \frac{\cancel{\omega} r_2}{\cancel{\omega} r_1} = \frac{2\cancel{r_1}}{\cancel{r_1}} = 2$$

$$V_{T_2} = 2V_{T_1}$$

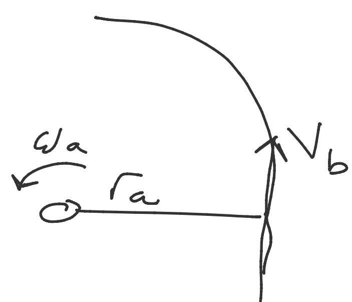


System Eqs

$\vec{V}_{bT} = \vec{\omega}_b r_b$

$\vec{V}_b = \vec{\omega}_a r_a$

$\boxed{V_{bT} = V_b}$



$r_a = ?$

$\vec{\omega}_a = 5 \frac{rad}{sec}$

$r_b = 80\ \underline{mm}$

$\vec{\omega}_b = 90 \frac{deg}{sec} \times \frac{\pi}{180} = \frac{\pi}{2} \frac{rad}{sec}$

$$\frac{2\pi\ rad}{360\ deg} = \frac{\pi\ rad}{180\ deg}$$

$r_b = 0.08m$

$r_b = 0.08\,m$

$\vec{\omega}_b = \pi/2 \ \frac{rad}{sec}$

1)

$V_{bT} = r_b \vec{\omega}_b = 0.08\,m \ \frac{\pi}{2} \frac{rad}{sec} = 0.126 \frac{m}{sec}$

2)

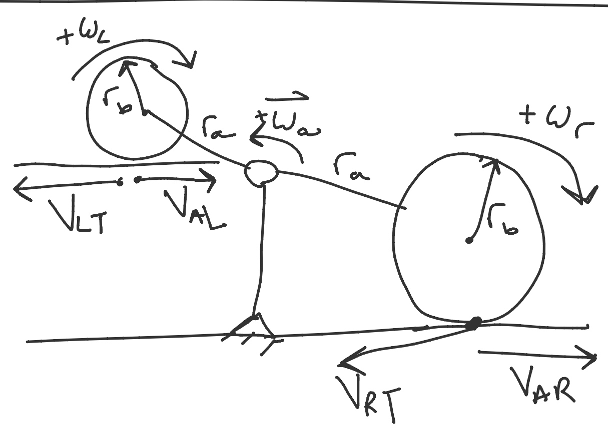
$V_{bT} = -V_b \Rightarrow V_b = -V_{bT} = -(0.126 \frac{m}{s})$

3) $\frac{|V_b|}{\omega_a} = \frac{r_a \omega_a}{\omega_a} \Rightarrow \quad r_a = \frac{|V_b|}{\omega_a} = \frac{.126 \frac{m}{s}}{5 \frac{rad}{sec}} = 0.0252\,m$

25.2 mm

2.52 cm

2wheel Rotation only System



Assumptions

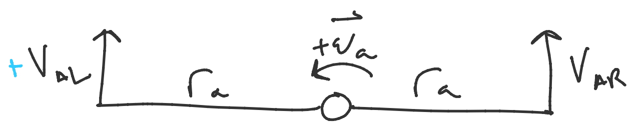
No Slip

$|V_{RT}| = |V_{AR}|$

$|V_{LT}| = |V_{AL}|$

Rotation Dynamics

$\vec{V}_T = \vec{\omega} r$



Right Wheel

$\vec{V}_{RT} = \vec{\omega}_r r_b$

Left Wheel

$\vec{V}_{LT} = \vec{\omega}_L r_b$

Superposition of $\vec{\omega}_a$

$\vec{\omega}_a = \vec{\omega}_{aR} + \vec{\omega}_{aL}$

$+V_{AR} = \vec{\omega}_{aR} r_a \Rightarrow \omega_{aR} = \frac{V_{AR}}{r_a}$

$-V_{AL} = \vec{\omega}_{aL} r_a \Rightarrow \omega_{aL} = \frac{-V_{AL}}{r_a}$

$\vec{\omega}_a = \vec{\omega}_{aR} + \vec{\omega}_{aL}$

$= \frac{V_{AR}}{} + \left(\frac{-V_{AL}}{}\right) = \frac{V_{AR} - V_{AL}}{} = \frac{(\vec{\omega}_r r_b) - (\vec{\omega}_L r_b)}{}$

$$= \frac{V_{AR}}{r_a} + \left(\frac{-V_{AL}}{r_a}\right) = \frac{\vec{V}_{AR} - \vec{V}_{AL}}{r_a} = \frac{(\vec{\omega}_r r_b) - (\vec{\omega}_L r_b)}{r_a}$$

$$\vec{\omega}_a = \frac{r_b(\vec{\omega}_r - \vec{\omega}_L)}{r_a}$$

pretend
$\vec{\omega}_R = \vec{\omega}_L$

$$= \frac{r_b}{r_a}(\omega_R - \omega_R)$$

$$\vec{\omega}_a = 0 = \cancel{\frac{r_b}{r_a}(0)} = 0$$

$$\vec{\omega}_a = \vec{\omega}_{aR} + \vec{\omega}_{aL}$$