AE 252 (Spring 2007)

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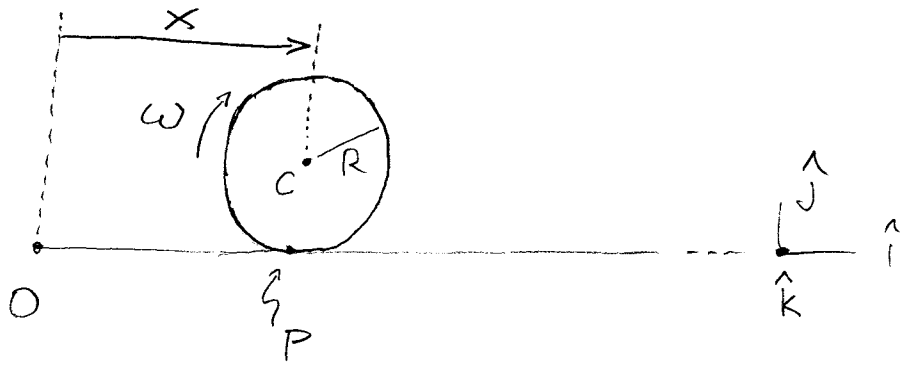
Example: wheels



- If a wheel turns at ω rad/sec clockwise and rolls without slipping, how fast is its center (point C) moving?

- "Rolls without slipping" $\longrightarrow$ The relative velocity of the contact point P with respect to the ground is zero.

- NOTE: The "contact point" is the point on the wheel that is instantaneously in contact with the ground — this point changes!

- Here, the ground is not moving. So $\vec{v}_P = 0$ when P contacts the ground.

We just derived ${}^F\vec{v}_P = {}^F\vec{v}_C + {}^F\vec{\omega}^B \times \vec{r}_{P/C}$.

${}^F\vec{v}_P = 0$

${}^F\vec{v}_C = \dot{x}\hat{i}$ ⟵ $\left\{ \vec{r}_C = x\hat{i} + R\hat{j} \right.$

${}^F\vec{\omega}^B = -\omega\hat{k}$

$\vec{r}_{P/C} = -R\hat{j}$ ⟵ at the instant P contacts the ground

So ...

$$0 = \dot{x}\hat{i} + \left(-\omega\hat{k} \times -R\hat{j}\right)$$

$$= \dot{x}\hat{i} - R\omega\hat{i}$$

$$\Rightarrow \boxed{\dot{x} = R\omega}$$ ⟵ so ${}^F\vec{v}_C = R\omega\hat{i}$.

In your homework you will examine the velocity of other points on the wheel.