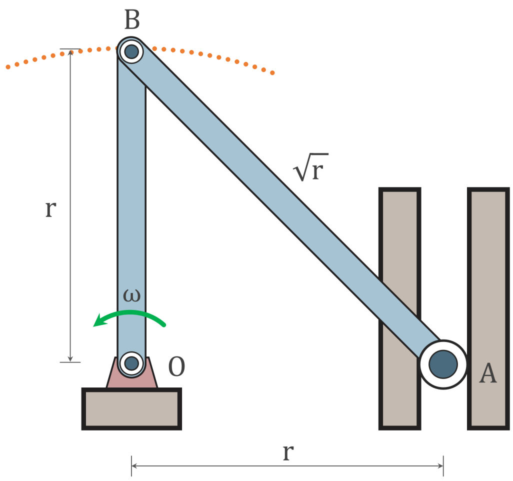
Angular Acceleration of Rolling Link



Determine the angular acceleration α_{AB} for the position shown if link OB has a constant angular velocity ω.

Using known expressions:

$$\boldsymbol{a_A} = \boldsymbol{a_B} + \boldsymbol{a_{A/B,n}} + +\boldsymbol{a_{A/B,t}} \tag{1}$$

$$\boldsymbol{a_{A/B,n}} = \boldsymbol{\omega} \times \boldsymbol{\omega} \times \boldsymbol{r_{A/B}} \tag{2}$$

$$\boldsymbol{a_{A/B,t}} = \boldsymbol{\alpha} \times \boldsymbol{r_{A/B}} \tag{3}$$

Given:
Constant angular velocity: ω
Point A is constraint to only move in vertical direction.

First step is to visualize the problem using kinematic diagrams, this is shown in Figures 1 and 2. Since the angular velocity of bar OB is zero, it has no angular acceleration and thus B has only an normal acceleration. This does not necessarily mean that bar AB also has an angular acceleration equal to zero.

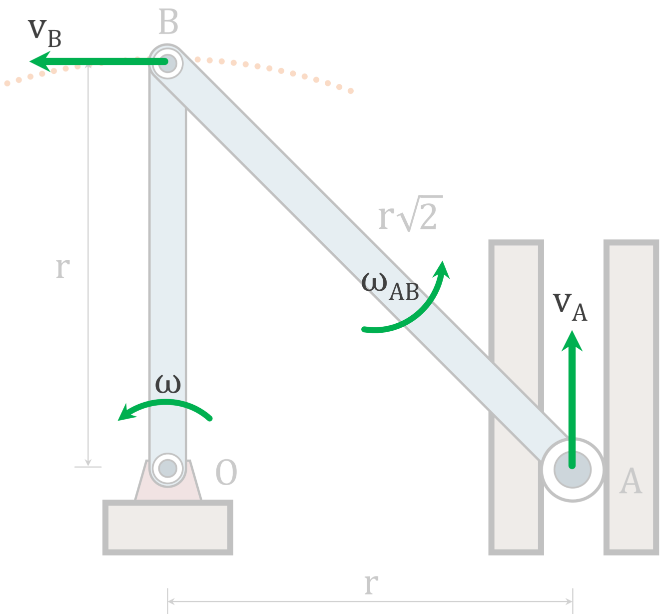


Figure 1: Kinematic diagram showing velocities.

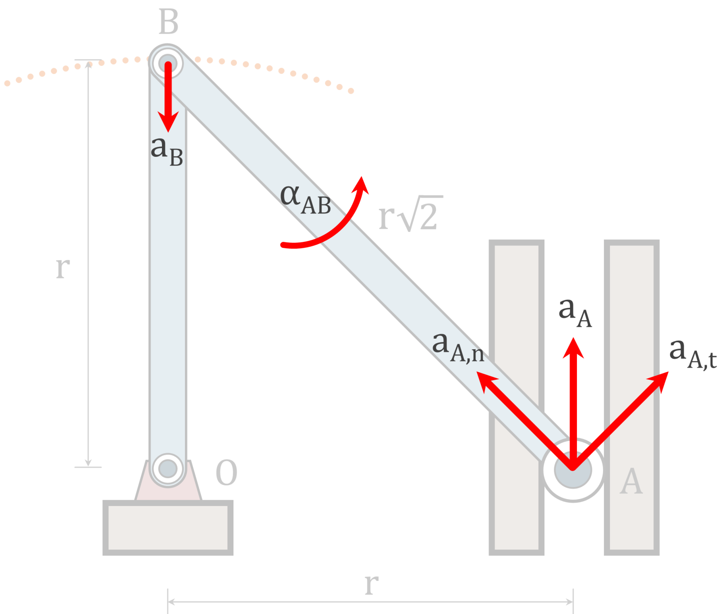


Figure 2: Kinematic diagram showing accelerations.

Using geometry it can be seen that $\angle OBA$ and $\angle OAB$ are both equal to 45°. This results in the same geometry for the acceleration vectors $a_{A/B,n}$ and $a_{A/B,t}$, this is shown in Figure 3. From this it follows that $a_{A/B,n}$ and $a_{A/B,t}$ are equal to each other. Using Equation 2 and 3, a relation for α_{AB} can be found.

$$a_{A/B,n} = a_{A/B,t} \quad \Rightarrow \quad \omega_{AB} \cdot \omega_{AB} \cdot R = \alpha_{AB} \cdot R \quad \Rightarrow \quad \alpha_{AB} = \omega_{AB}^2 \tag{4}$$

Since point O is the instantaneous centre of zero velocity all angular velocities $(\omega_{OB}, \omega_{AB}, \omega_{OA})$ are the same. Thus $\alpha_{AB} = \omega^2$.

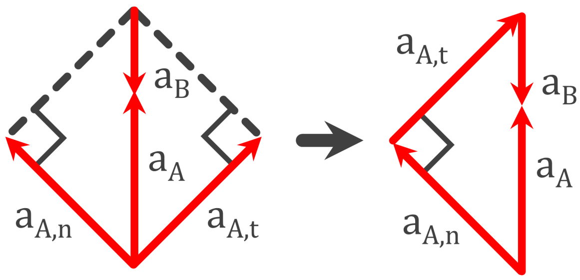


Figure 3: Geometric relations of acceleration vectors.