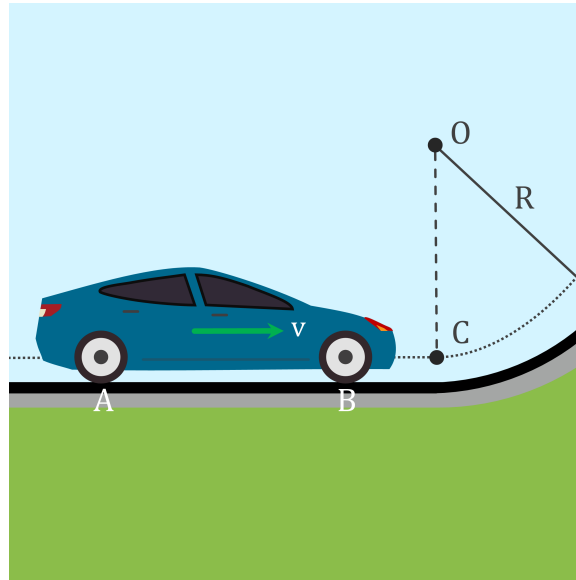# Chassis of Car at Circular Road Portion

Determine the angular acceleration of the chassis AB of a car just after wheel B passes point C and enters the circular inclined portion of the road surface. Assume the wheels of the car follow a circular path with radius R and centre of curvature O after it passes point C. The distance between A and B is given by L.

Using known expressions:

$$\boldsymbol{v} = \boldsymbol{\omega} \times \boldsymbol{R} \tag{1}$$

$$\boldsymbol{a_n} = \boldsymbol{\omega} \times \boldsymbol{\omega} \times \boldsymbol{R} \tag{2}$$

$$\boldsymbol{a_t} = \boldsymbol{\alpha} \times \boldsymbol{R} \tag{3}$$

Given:
Velocity of the car: v

First step is to visualize the problem using a kinematic diagram, this is shown in Figure 1. It can be seen that at this time instant the chassis just begins at the curvature. It has a horizontal velocity v, and thus no angular velocity ω_{AB}. This means that using Equation 2 it can be seen that for point B with respect to point A

the acceleration component in the horizontal direction (a_n) is zero. Only the vertical component as a result from Equation 3 remains, where $\alpha = \alpha_{AB}$ and $R = L$. This results in:

$$a_B = \alpha_{AB} \cdot L \tag{4}$$

We can do the same analysis starting at point O instead of point A. The acceleration of point B with respect to point O can also be split up in a normal and tangential component. Where the normal component must be equal to the tangential component (a_B) as calculated before. Using Equation 2 this becomes:

$$a_B = a_n = \omega_{OB} \cdot \omega_{OB} \cdot R \tag{5}$$

Since we know that the velocity at point B is equal to v. Using Equation 1 ω_{OB} can be rewritten to:

$$\omega_{OB} = \frac{v}{R} \tag{6}$$

Inserting this in Equation 5 gives:

$$a_B = \frac{v^2}{R} \tag{7}$$

From Equation 4 and 7 a relation for α_{AB} can be found.

$$a_B = \alpha_{AB} \cdot L = \frac{v^2}{R} \quad \Rightarrow \quad \alpha_{AB} = \frac{v^2}{R \cdot L} \tag{8}$$
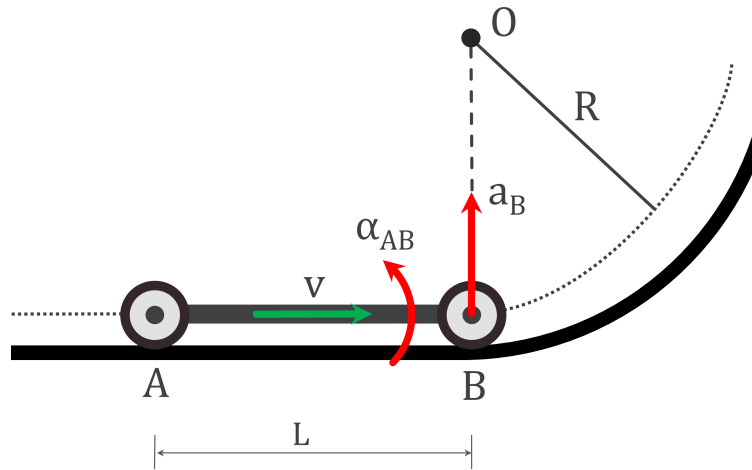

Figure 1: Kinematic diagram of the chassis of the car at a circular road portion. Where point B passes point C.