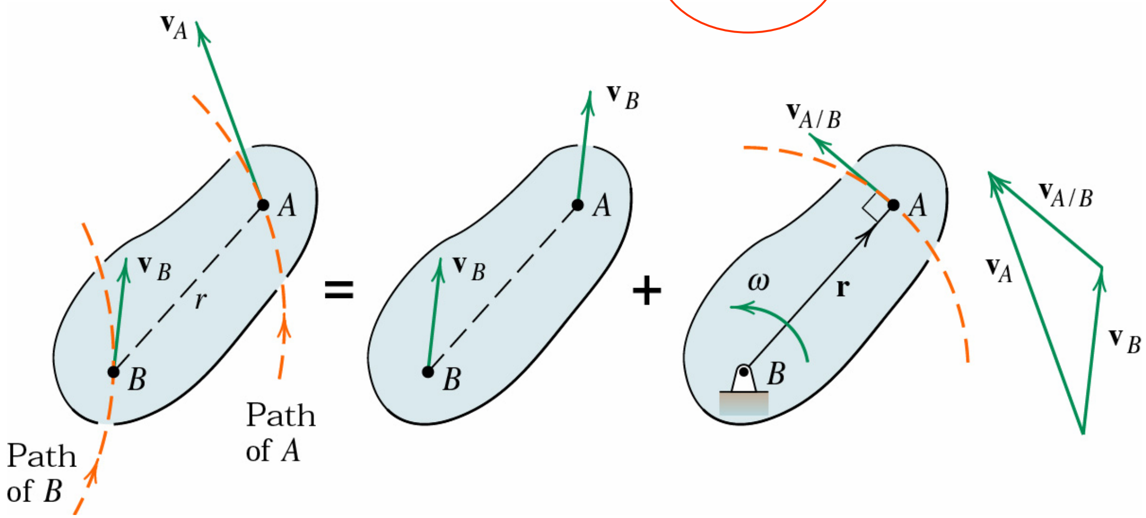
Relative acceleration (1)

From relative velocity $\vec{v}_A = \vec{v}_B + \vec{v}_{A/B}$ → Circular motion

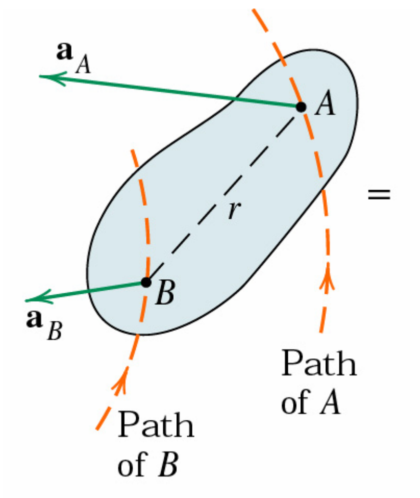


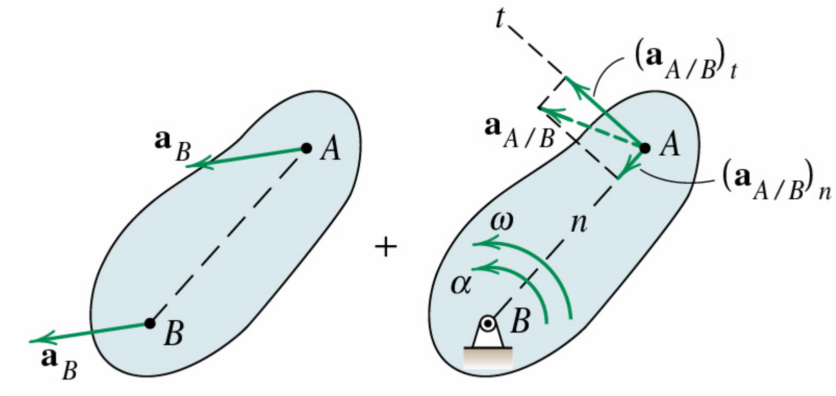
Observers at *B* see point *A* moving in a circle around point *B* → Direction of $\vec{v}_{A/B}$ is always known

Acceleration $\vec{a}_A = \vec{a}_B + \vec{a}_{A/B}$

Direction of $\vec{a}_{A/B}$ is usually unknown → Consider *n-t* components of $\vec{a}_{A/B}$ instead

Relative acceleration (2)





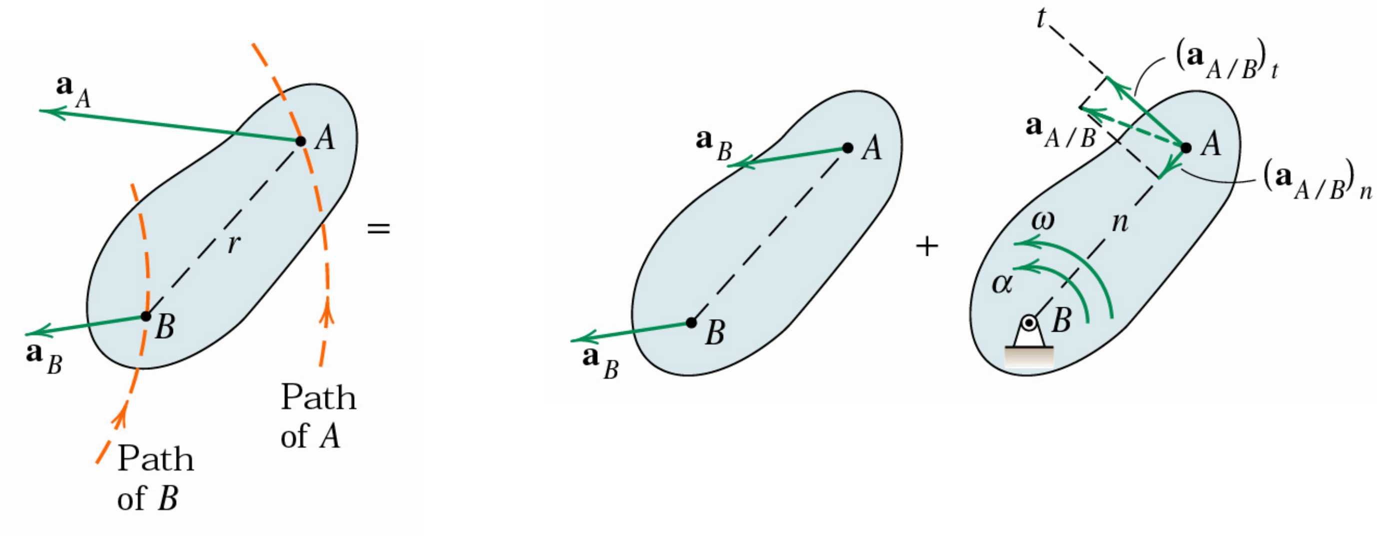
Observers at B see point A moving in a circle around point B

$$\vec{a}_A = \vec{a}_B + \vec{a}_{A/B} = \vec{a}_B + (\vec{a}_{A/B})_n + (\vec{a}_{A/B})_t$$

→ Circular motion

	$(\vec{a}_{A/B})_n$	$(\vec{a}_{A/B})_t$
Direction	⇨ $\overline{AB}$	⇨ $\perp \overline{AB}$
Magnitude	⇨ $v_{A/B}^2 / r = r\omega_{AB}^2$ ⇨ $\vec{\omega} \times (\vec{\omega} \times \vec{r})$	⇨ $r\alpha$ ⇨ $\vec{\alpha} \times \vec{r}$

Relative acceleration (3)

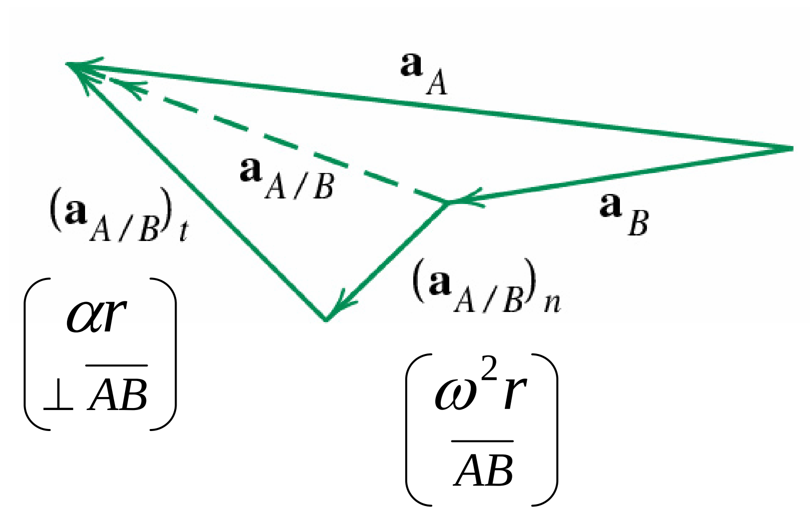


$$\vec{a}_A = \vec{a}_B + (\vec{a}_{A/B})_n + (\vec{a}_{A/B})_t$$

Mag.	×	○	$\omega^2 r$	×
Dir.	○	○	$\overline{AB}$	$\perp \overline{AB}$

⇩

Two unknowns can be solved



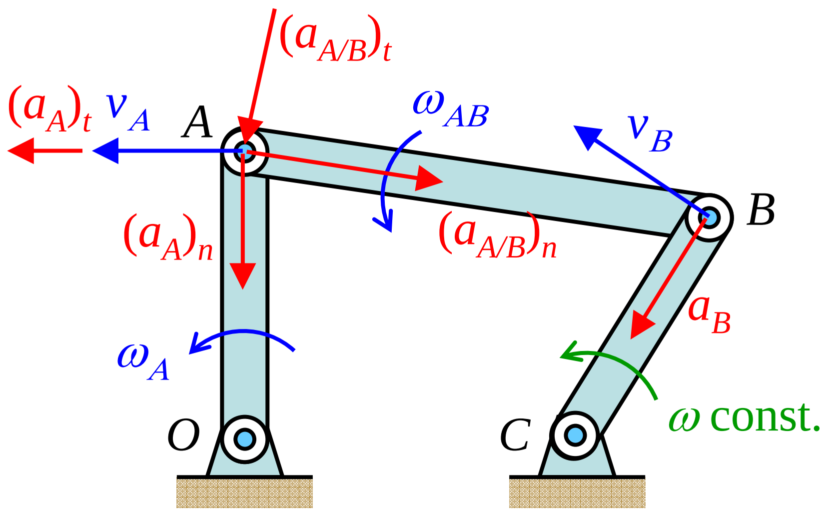
Relative acceleration (4)

Frequently the magnitude and direction of $\vec{a}_A$ are unknown. In these cases *n*-*t* components of $\vec{a}_A$ should be considered instead.

$$\vec{a}_A = \vec{a}_B + (\vec{a}_{A/B})_n + (\vec{a}_{A/B})_t$$

$$(\vec{a}_A)_n + (\vec{a}_A)_t = \vec{a}_B + (\vec{a}_{A/B})_n + (\vec{a}_{A/B})_t$$

Mag.	$\omega_A^2 r_A$	×	○	$\omega_{AB}^2 \overline{AB}$	×
Dir.	○	○	○	$\overline{AB}$	$\perp \overline{AB}$



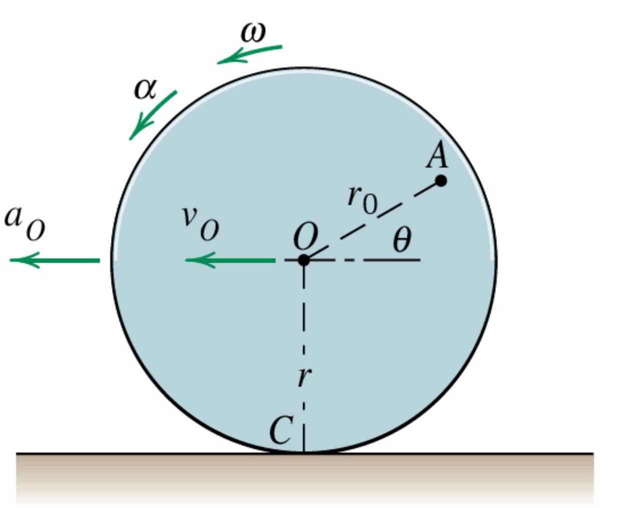
Direction of a_A ?

⇩

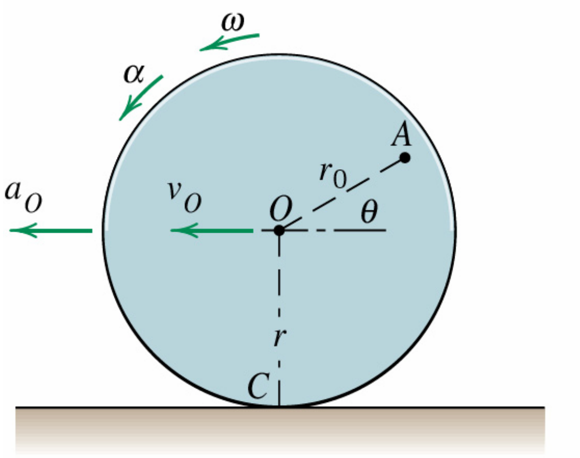
Dir. of $(a_A)_n$ // $\overline{OA}$
$(a_A)_t$ $\perp \overline{OA}$

Sample problem 5/13

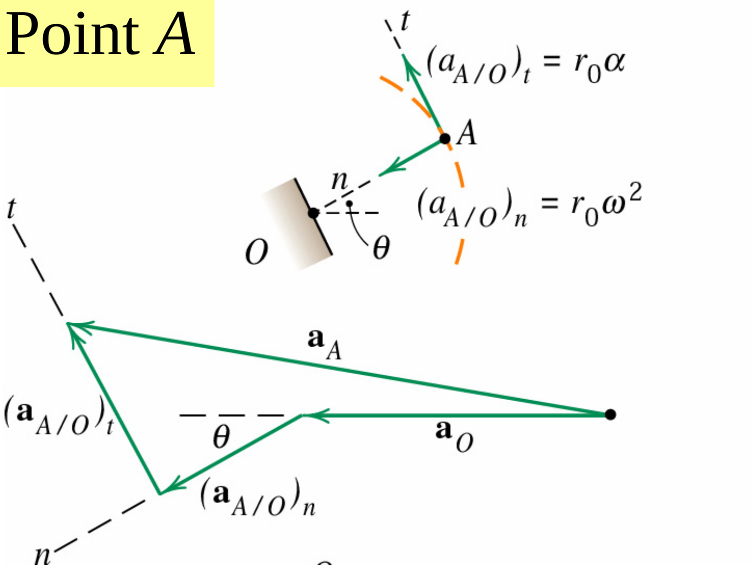
The wheel of radius r rolls to the left without slipping and, at the instant considered, the center O has a velocity $\vec{v}_O$ and an acceleration $\vec{a}_O$ to the left. Determine the acceleration of point A and C on the wheel for the instant considered.



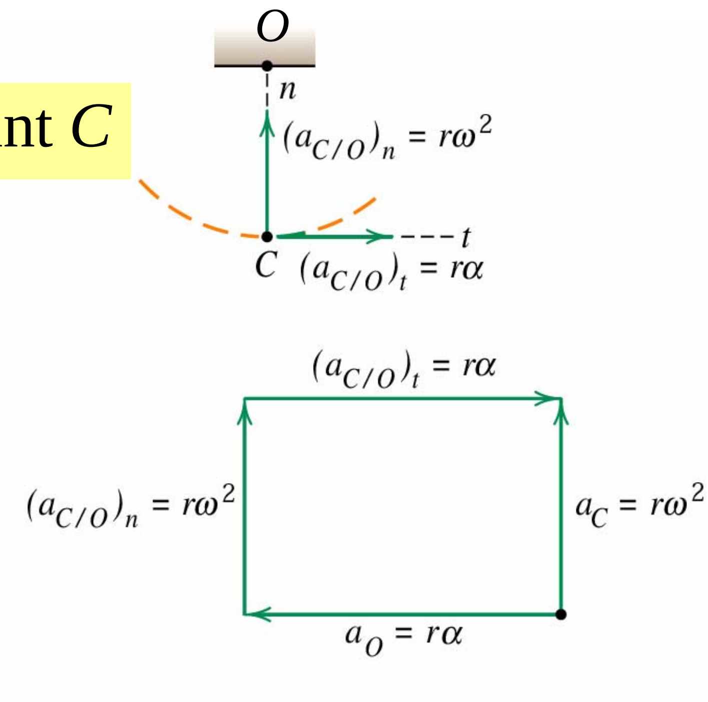
Sample problem 5/13



Point *A*

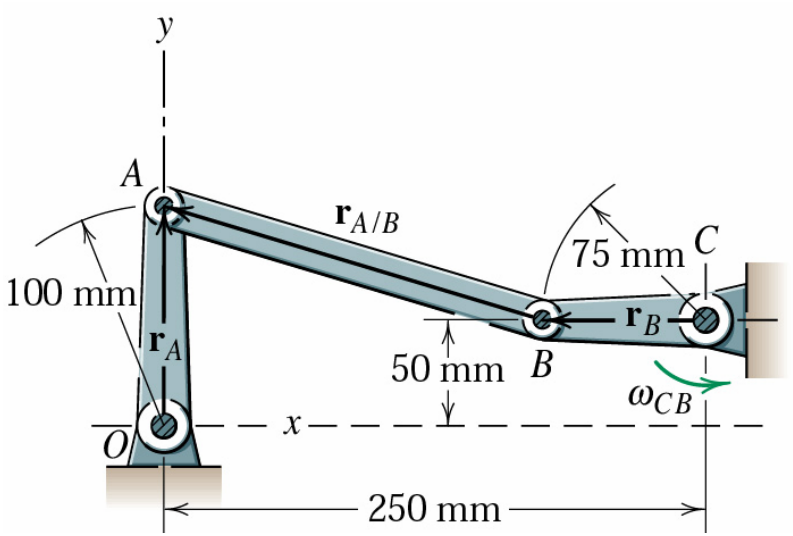


Point *C*



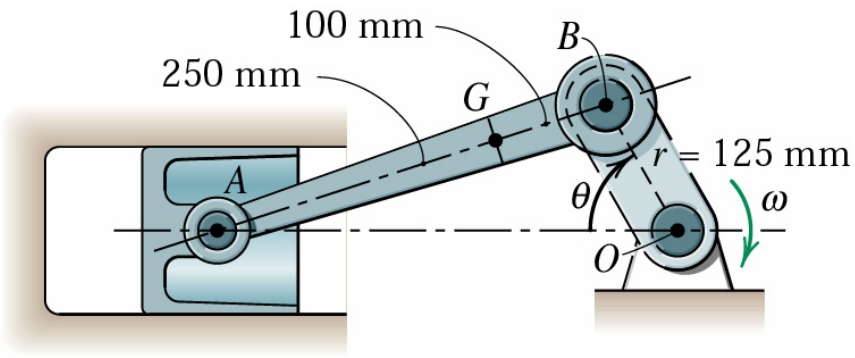
Sample problem 5/14

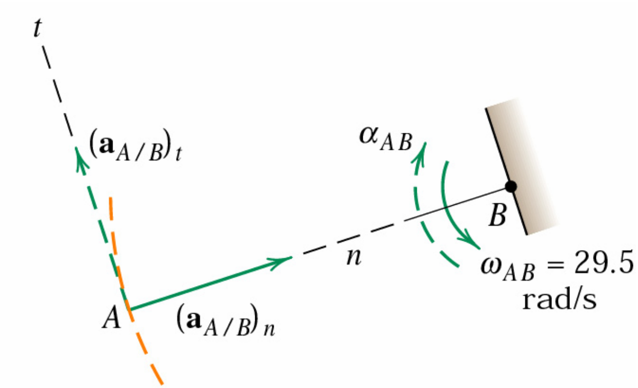
The linkage of Sample Problem 5/8 is repeated here. Crank *CB* has a constant CCW angular velocity of 2 rad/s in the position shown during a short interval of its motion. Determine the angular acceleration of link *AB* and *OA* for this position. Solve by using vector algebra.

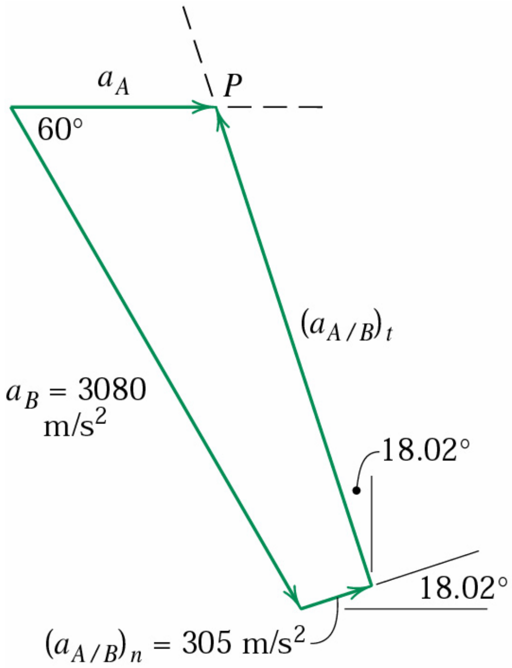


Sample problem 5/15

The slider-crank mechanism of Sample problem 5/9 is repeated here. The crank *OB* has a constant CW angular speed of 1500 rev/min. For the instant when the crank angle θ is 60°, determine the acceleration of the piston *A* and the angular acceleration of the connecting rod *AB*.

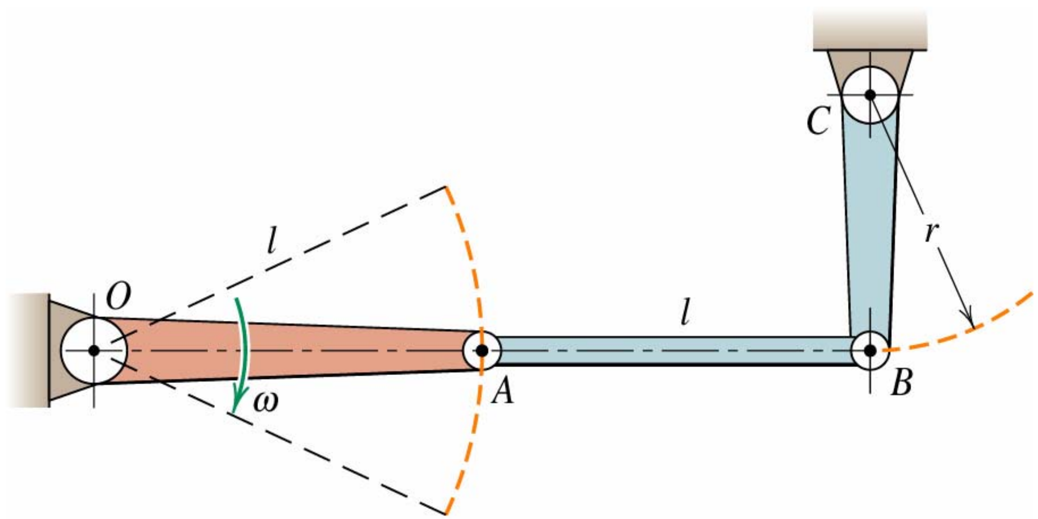






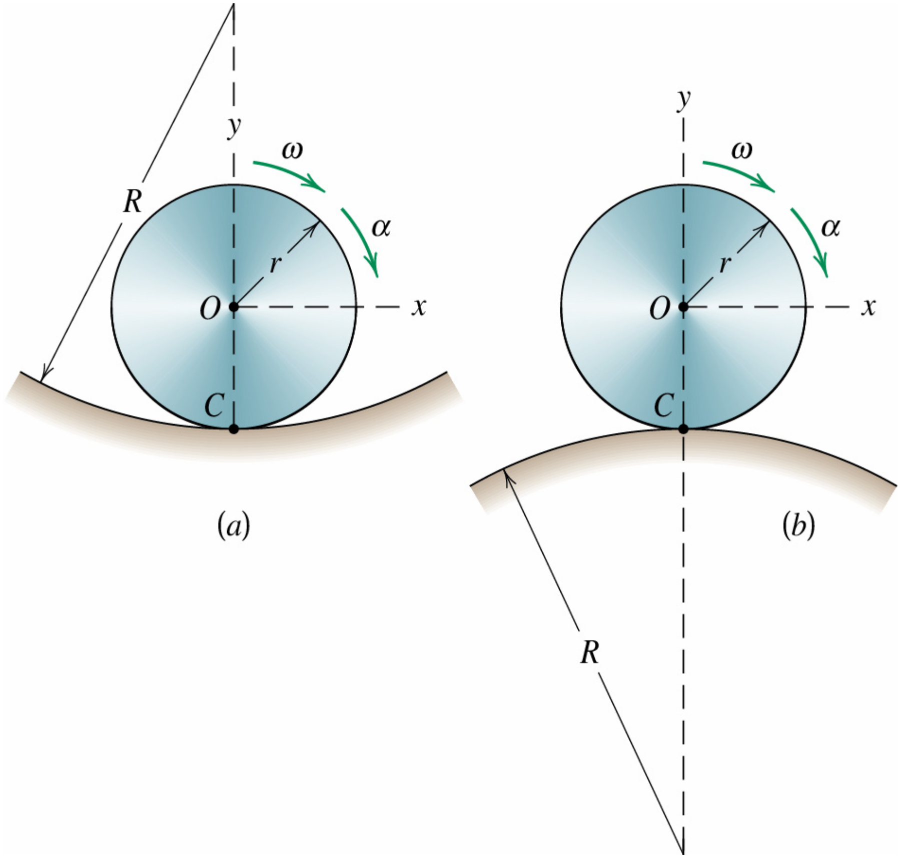
Sample 4 (5/135)

Crank *OA* oscillates between the dashed positions shown and causes small angular motion of crank *BC* through the connecting link *AB*. When *OA* crosses the horizontal position with *AB* horizontal and *BC* vertical, it has an angular velocity ω and zero angular acceleration. Determine the angular acceleration of *BC* for this position.



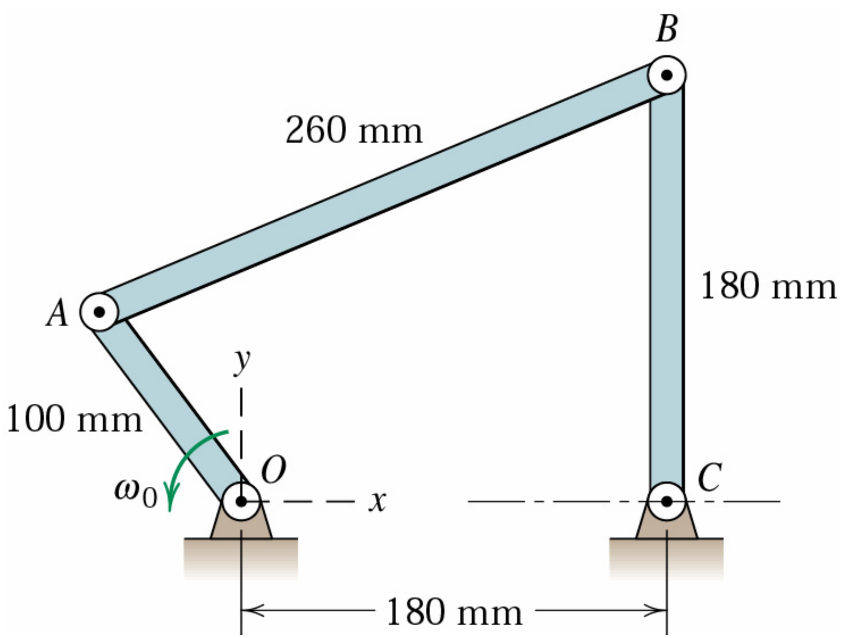
Sample 5 (5/140)

If the wheel in each case rolls on the circular surface without slipping, determine the acceleration of point C on the wheel momentarily in contact with the circular surface. The wheel has an angular velocity ω and an angular acceleration α.



Sample 6 (5/141)

If *OA* has a constant CCW angular velocity ω_O = 10 rad/s, calculate the angular acceleration of link *AB* for the position where the coordinates of *A* are $x = -60$ mm and $y = 80$ mm. Link *BC* is vertical for this position. (Use results of Prob. 5/83, which are $\omega_{BC} = 5.83\mathbf{k}$ rad/s and $\omega_{AB} = 2.5\mathbf{k}$ rad/s.)



Sample 7 (5/148)

A mechanism for pushing small boxes from an assembly line onto a conveyor belt is shown with arm *OD* and crank *CB* in their vertical positions. For the configuration shown, crank *CB* has a constant CW angular velocity of π rad/s. Determine the acceleration of *E*.