Angular				Tangential			
θ	rads	revs	degrees	s	m	cm	km
ω	$\frac{\text{rads}}{\text{s}}$	$\frac{\text{revs}}{\text{s}}$	$\frac{\text{degrees}}{\text{s}}$	v_t	m/s	cm/s	km/s
α	$\frac{\text{rads}}{\text{s}^2}$	$\frac{\text{revs}}{\text{s}^2}$	$\frac{\text{degrees}}{\text{s}^2}$	a_t	m/s^2	km/s^2	cm/s^2

Angular				Tangential			
	1	2	3		4	5	6
θ	rads	revs	degrees	s	m	cm	km
ω	$\frac{\text{rads}}{\text{s}}$	$\frac{\text{revs}}{\text{s}}$	$\frac{\text{degrees}}{\text{s}}$	v_t	m/s	cm/s	km/s
α	$\frac{\text{rads}}{\text{s}^2}$	$\frac{\text{revs}}{\text{s}^2}$	$\frac{\text{degrees}}{\text{s}^2}$	a_t	m/s^2	km/s^2	cm/s^2

Angular			
θ	1 rads	2 revs	3 degrees
ω	3 $\frac{\text{rads}}{\text{s}}$	2 $\frac{\text{revs}}{\text{s}}$	1 $\frac{\text{degrees}}{\text{s}}$
α	$\frac{\text{rads}}{\text{s}^2}$	$\frac{\text{revs}}{\text{s}^2}$	$\frac{\text{degrees}}{\text{s}^2}$

Tangential			
s	4 m	5 cm	6 km
v_t	5 m/s	4 cm/s	6 km/s
a_t	m/s^2	km/s^2	cm/s^2

	Angular				Tangential		
θ	1 rads	2 revs	3 degrees	s	4 m	5 cm	6 km
ω	3 $\frac{\text{rads}}{\text{s}}$	2 $\frac{\text{revs}}{\text{s}}$	1 $\frac{\text{degrees}}{\text{s}}$	v_t	5 m/s	4 cm/s	6 km/s
α	1 $\frac{\text{rads}}{\text{s}^2}$	3 $\frac{\text{revs}}{\text{s}^2}$	2 $\frac{\text{degrees}}{\text{s}^2}$	a_t	4 m/s^2	6 km/s^2	5 cm/s^2

	Angular		
θ	1 rads	2 revs	3 degrees
ω	3 $\frac{\text{rads}}{\text{s}}$	2 $\frac{\text{revs}}{\text{s}}$	1 $\frac{\text{degrees}}{\text{s}}$
α	1 $\frac{\text{rads}}{\text{s}^2}$	3 $\frac{\text{revs}}{\text{s}^2}$	2 $\frac{\text{degrees}}{\text{s}^2}$

	Tangential		
s	4 m	5 cm	6 km
v_t	5 m/s	4 cm/s	6 km/s
a_t	4 m/s^2	6 km/s^2	5 cm/s^2

$$s = \theta r$$

$$v_t = \omega r$$

$$a_t = \alpha r$$

How does ω compare for points S and R?

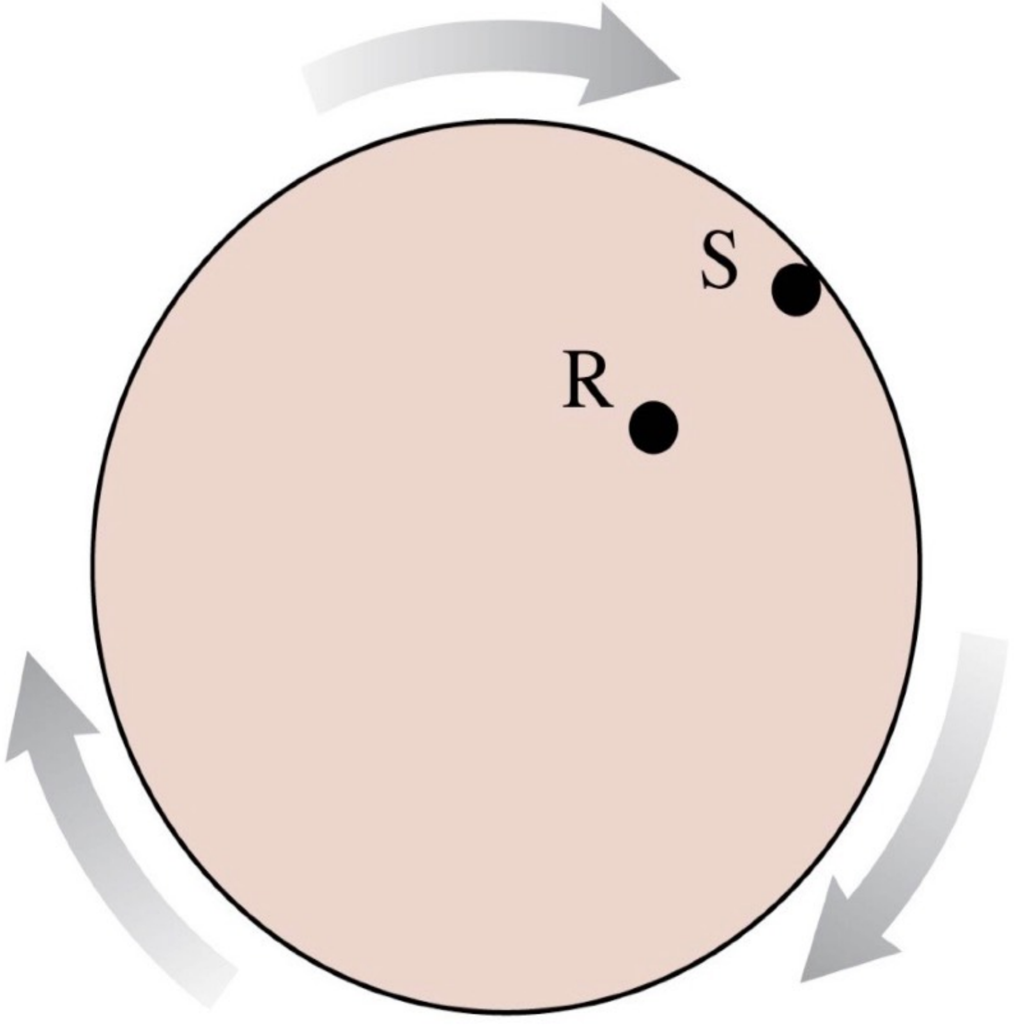
How does compare for points S and R?

How do the accelerations compare for points S and R?

How does ω compare for points S and R?

How does v_t compare for points S and R?

How do the accelerations compare for points S and R?



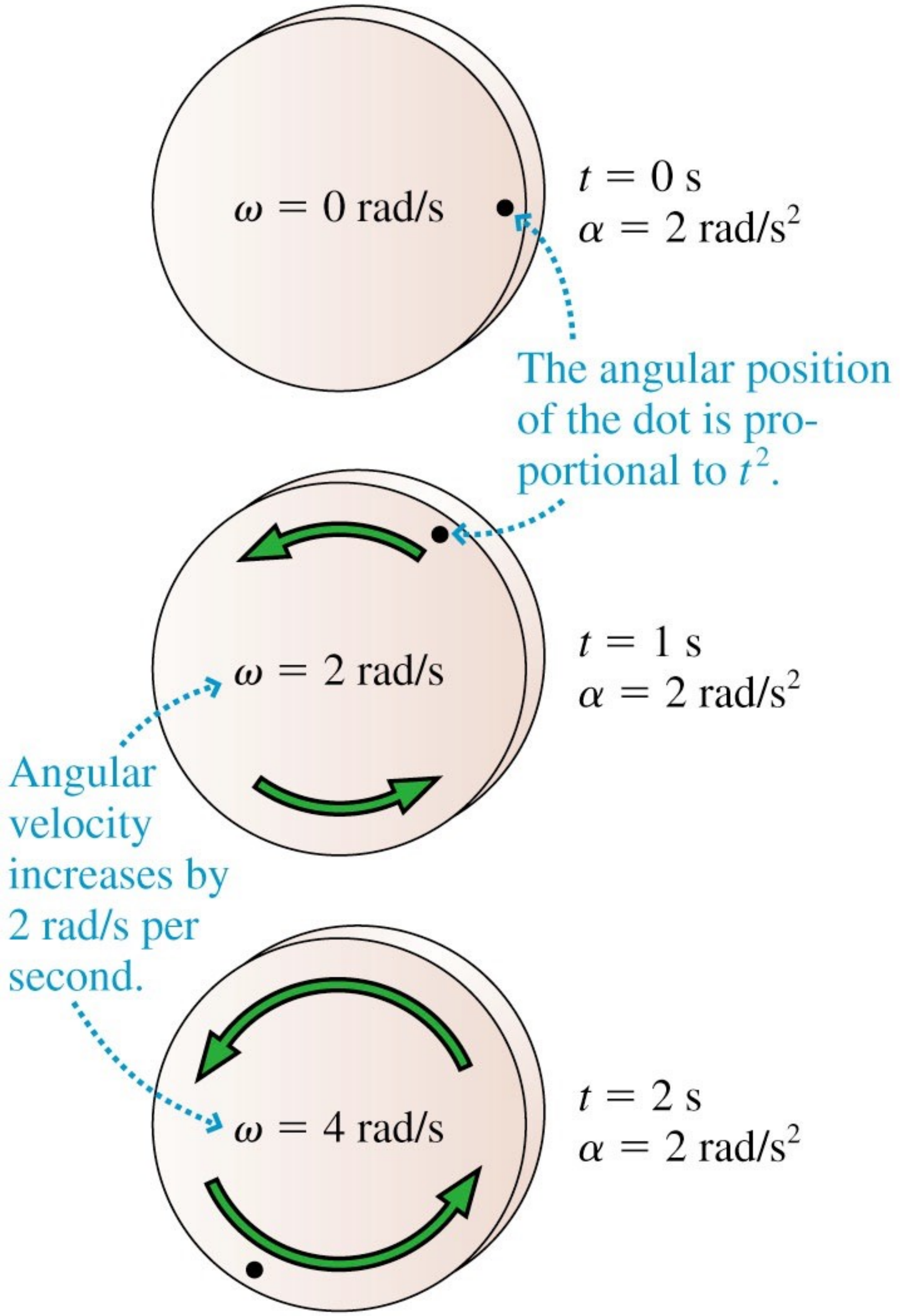
Angular Acceleration

Nonuniform circular motion

$$\alpha \equiv \frac{d\omega}{dt} \qquad \text{(angular acceleration)}$$

units of $\dfrac{\text{rad}}{\text{s}^2}$

$$a_t = \alpha r$$



Question

The fan blade is slowing down.
What are the signs of ω and α?

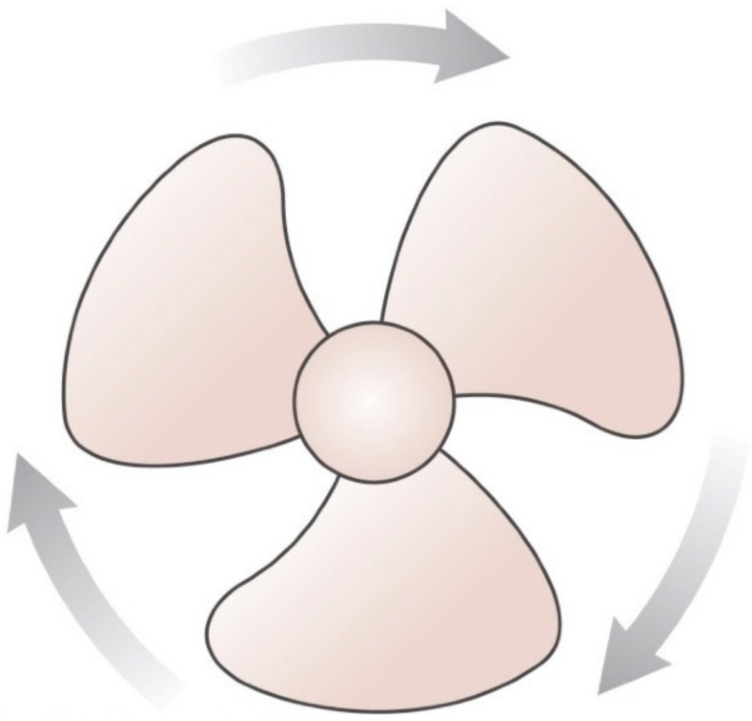
A. ω is positive and α is positive.

B. ω is positive and α is negative.

C. ω is negative and α is positive.

D. ω is negative and α is negative.

E. ω is positive and α is zero.



Quiz

The fan blade is slowing down.
What are the signs of ω and α?

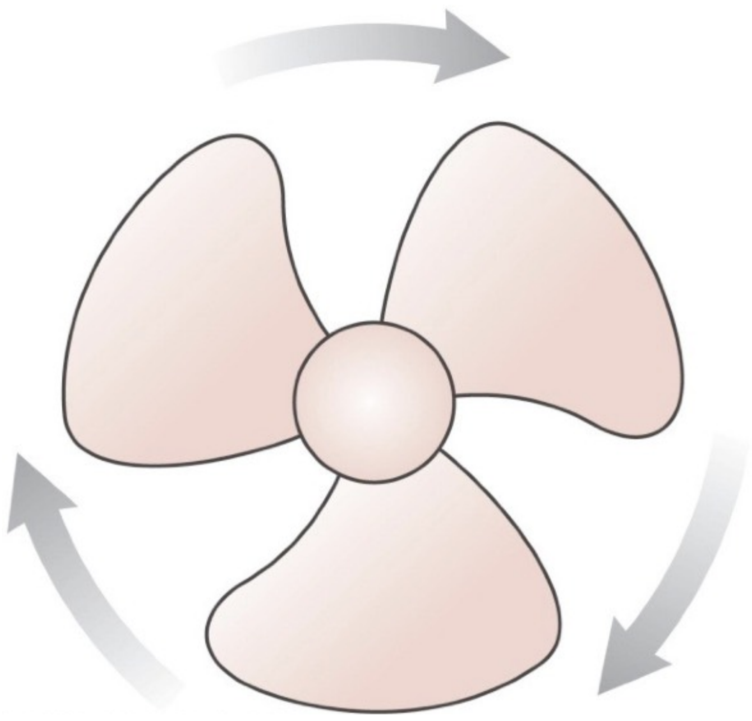
A. ω is positive and α is positive.

B. ω is positive and α is negative.

C. ω is negative and α is positive.

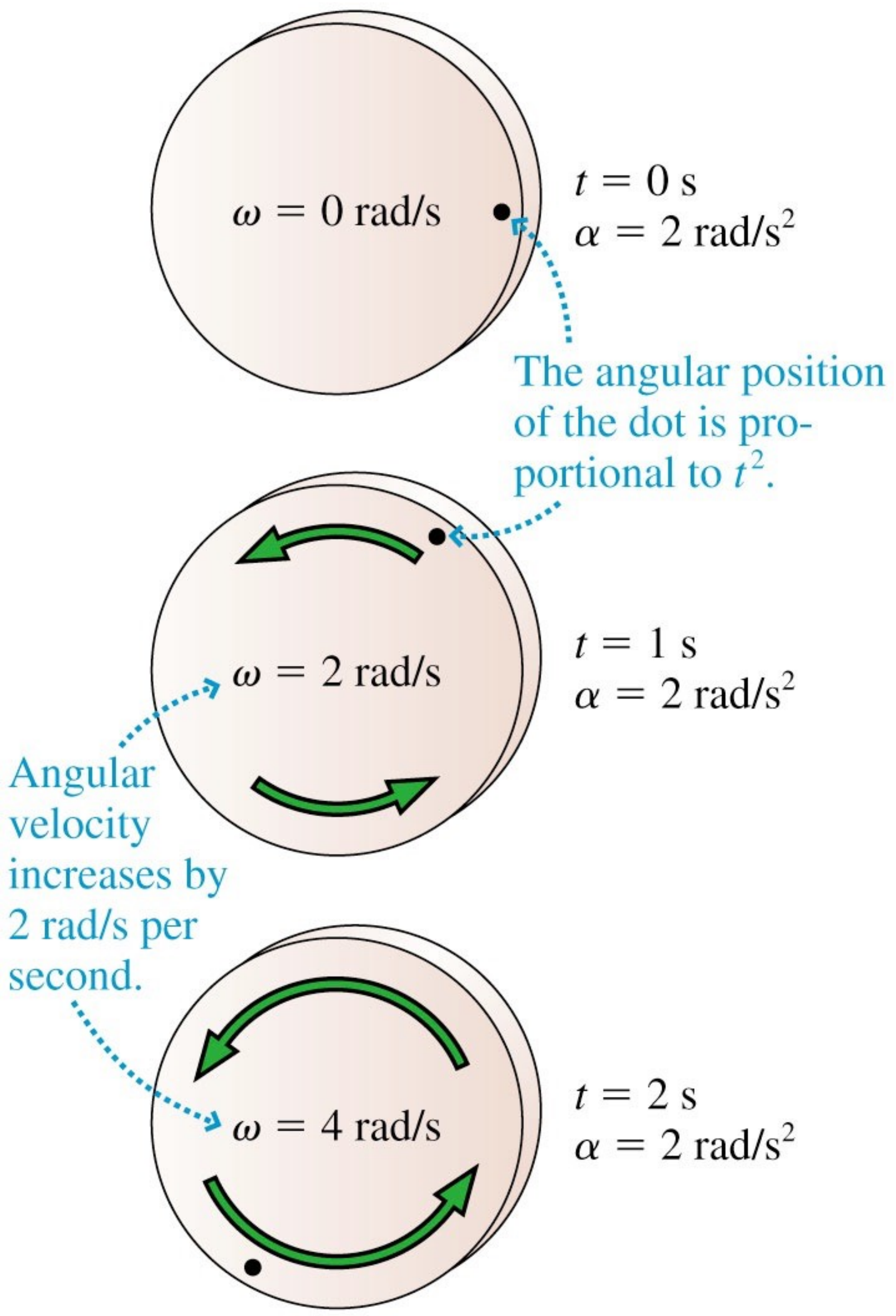
D. ω is negative and α is negative.

E. ω is positive and α is zero.



Angular Acceleration

- α is positive if $|\omega|$ is increasing and ω is counter-clockwise.
- α is positive if $|\omega|$ is decreasing and ω is clockwise.
- α is negative if $|\omega|$ is increasing and ω is clockwise.
- α is negative if $|\omega|$ is decreasing and ω is counter-clockwise.

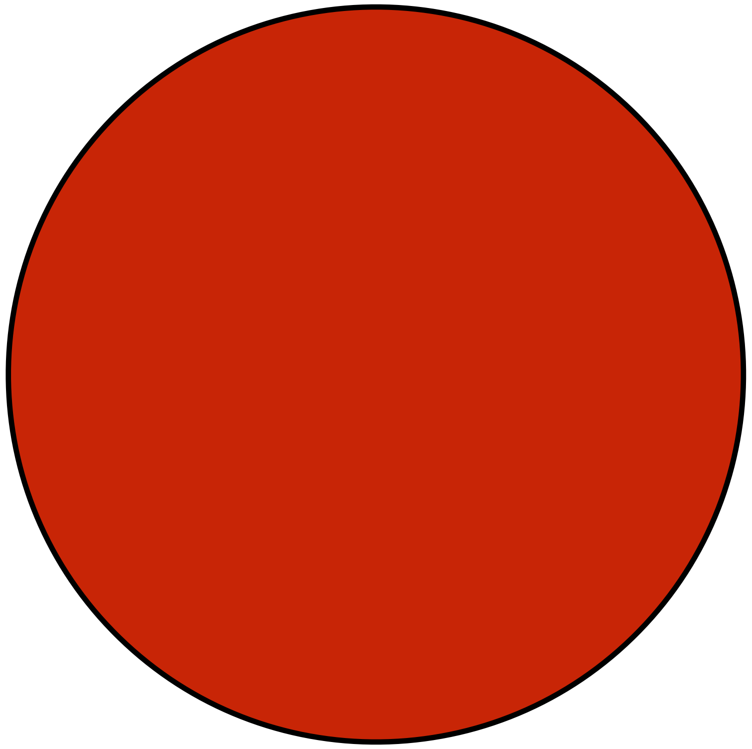


Angular Kinematics

Rotational kinematics	Linear kinematics
$\omega_f = \omega_i + \alpha\,\Delta t$	$v_{fs} = v_{is} + a_s\,\Delta t$
$\theta_f = \theta_i + \omega_i\,\Delta t + \frac{1}{2}\alpha(\Delta t)^2$	$s_f = s_i + v_{is}\,\Delta t + \frac{1}{2}a_s(\Delta t)^2$
$\omega_f^2 = \omega_i^2 + 2\alpha\,\Delta\theta$	$v_{fs}{}^2 = v_{is}{}^2 + 2a_s\,\Delta s$

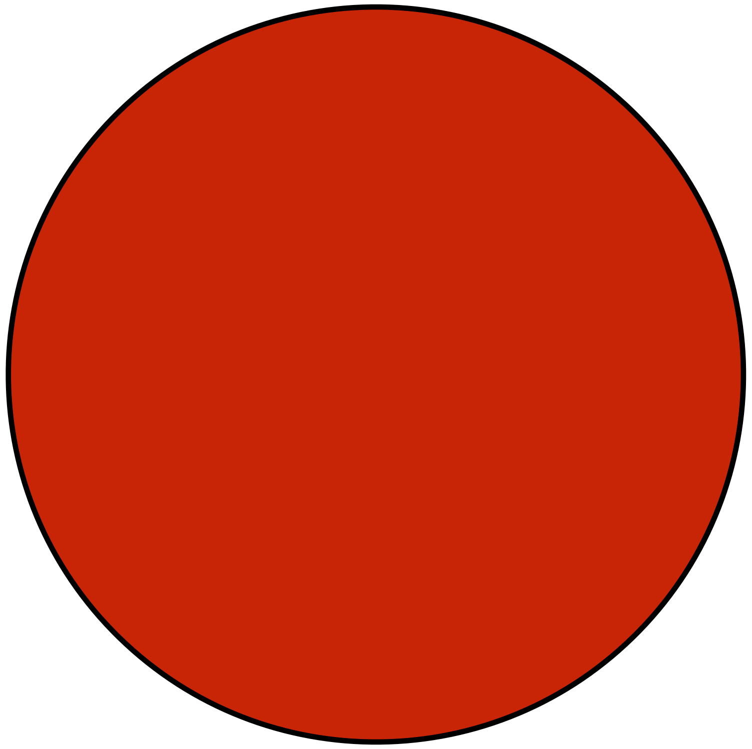
Conceptualizing Circular Motion

A merry-go-round is spinning at a rate of 0.5 revs/s and is slowing at a rate of 0.034 rad/s^2. Through how many radians will the merry-go-round turn through as it comes to rest.



Conceptualizing Circular Motion

A merry-go-round is initially at rest. You begin pushing on it and cause it to speed up. After pushing for 2 minutes you measure the speed of the merry-go-round to be 1.5 revs/second. What was the acceleration of the wheel?



Turbine Problem

A turbine is spinning at 3800 rpm. Friction in the bearings is so low that it takes 10 min to coast to a stop. How many revolutions does the turbine make while stopping?

New Equations

$$\vec{v}_t = \omega r$$

$$\vec{a}_c = \frac{v_t^2}{r}$$

$$\omega = \frac{d\theta}{dt}$$

$$v_t = \frac{ds}{dt}$$

$$s = r\theta$$

$$a_t = \alpha r$$

$$\omega_f = \omega_i + \alpha \Delta t$$

$$\theta_f = \theta_i + \omega_i \Delta t + \frac{1}{2}\alpha \Delta t^2$$

$$\alpha = \frac{d\omega}{dt}$$

$$\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$$

New Equations

$$\vec{v}_t = \omega r \quad \boxed{5}$$

$$\vec{a}_c = \frac{v_t^2}{r} \quad \boxed{8}$$

$$\omega = \frac{d\theta}{dt} \quad \boxed{2}$$

$$v_t = \frac{ds}{dt} \quad \boxed{7}$$

$$s = r\theta \quad \boxed{3}$$

$$a_t = \alpha r \quad \boxed{9}$$

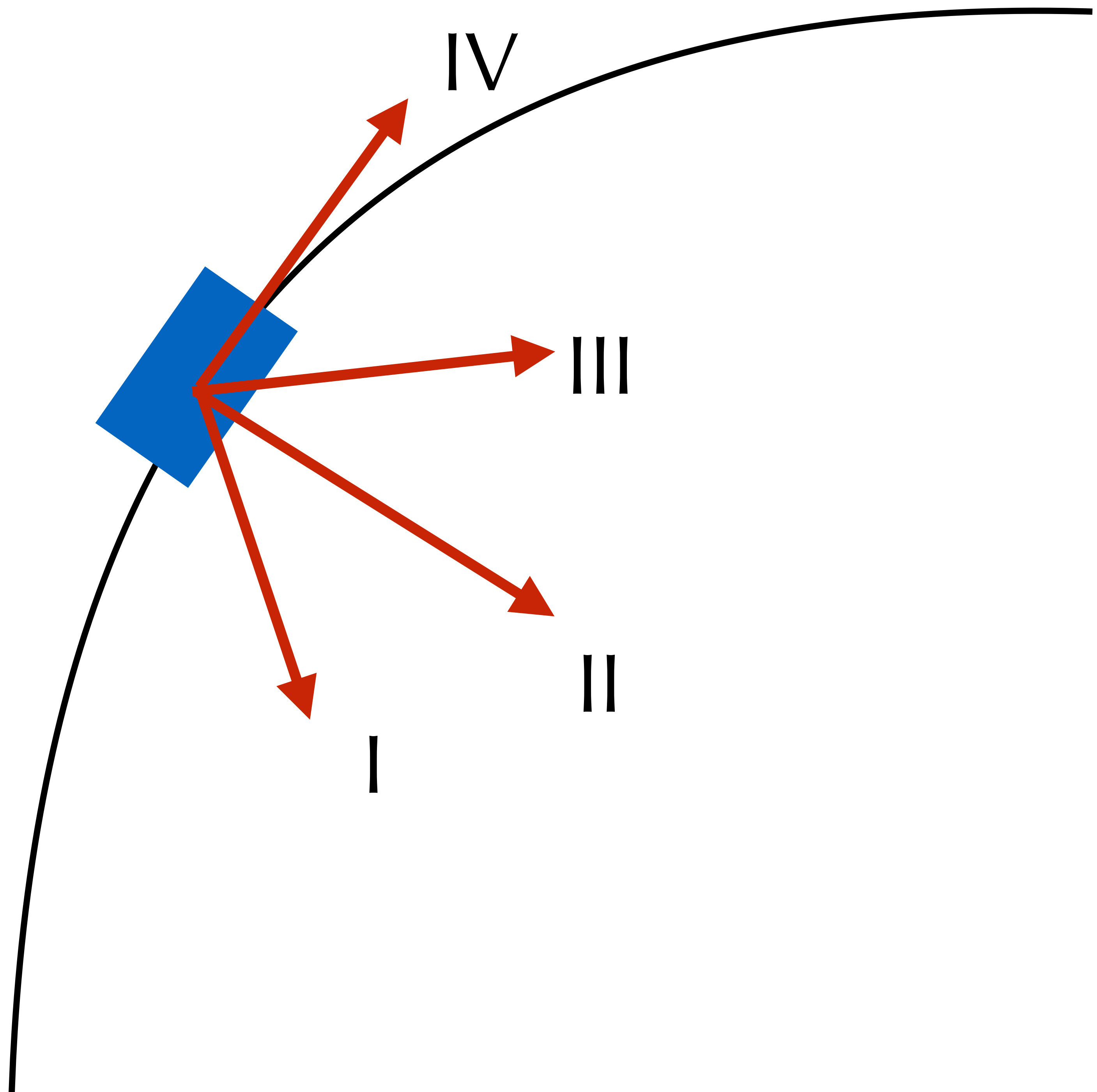
$$\omega_f = \omega_i + \alpha \Delta t \quad \boxed{1}$$

$$\theta_f = \theta_i + \omega_i \Delta t + \frac{1}{2}\alpha \Delta t^2 \quad \boxed{6}$$

$$\alpha = \frac{d\omega}{dt} \quad \boxed{4}$$

$$\omega_f^2 = \omega_i^2 + 2\alpha \Delta\theta \quad \boxed{10}$$

A car is speeding up as it goes around a curve. What is the acceleration vector at this moment in time?



Acceleration in Nonuniform Circular Motion

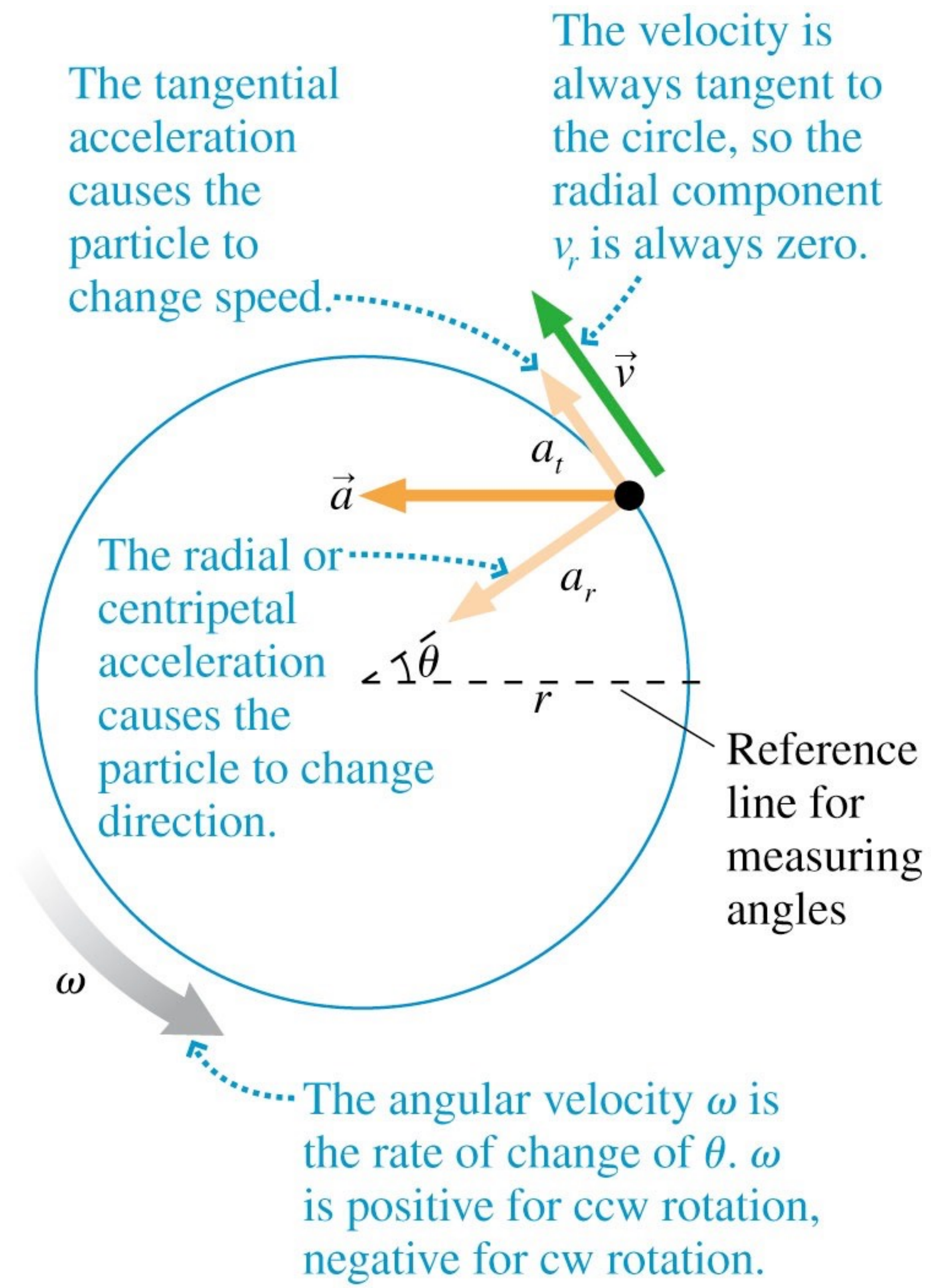
$\boxed{\text{Centripetal acceleration}}$

$$a_r = \frac{v^2}{r}$$

$\boxed{\text{Tangential acceleration}}$

$$a_t = \frac{ds}{dt}$$

$$a = \sqrt{{a_r}^2 + {a_t}^2}$$



Car on a curve

A car starts from rest on a curve of radius 50 m and accelerates at a rate of 4.0 m/s^2. After 2.0 s what is the **total** acceleration of the car?