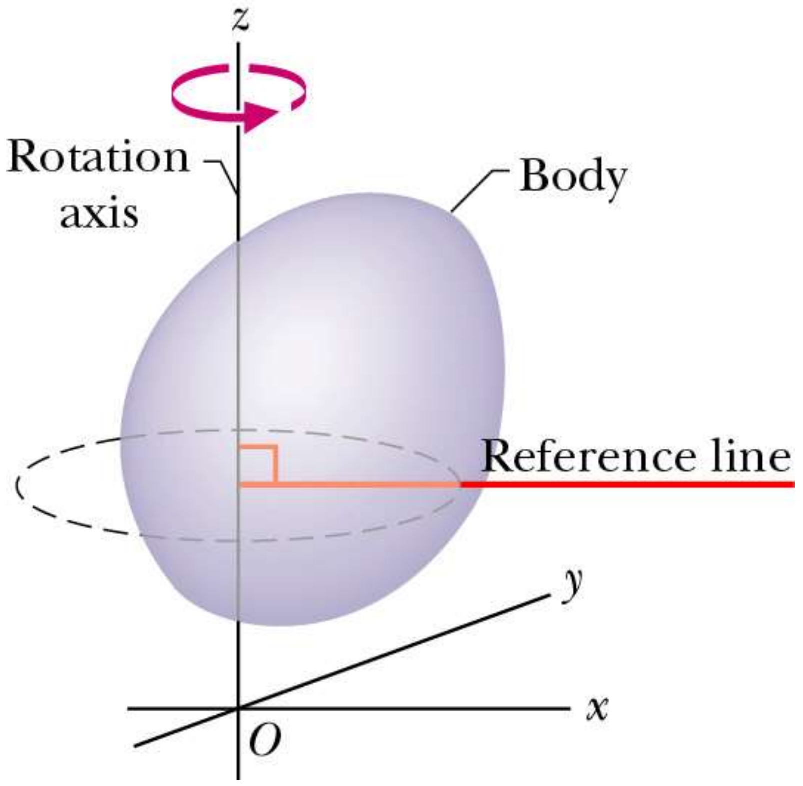
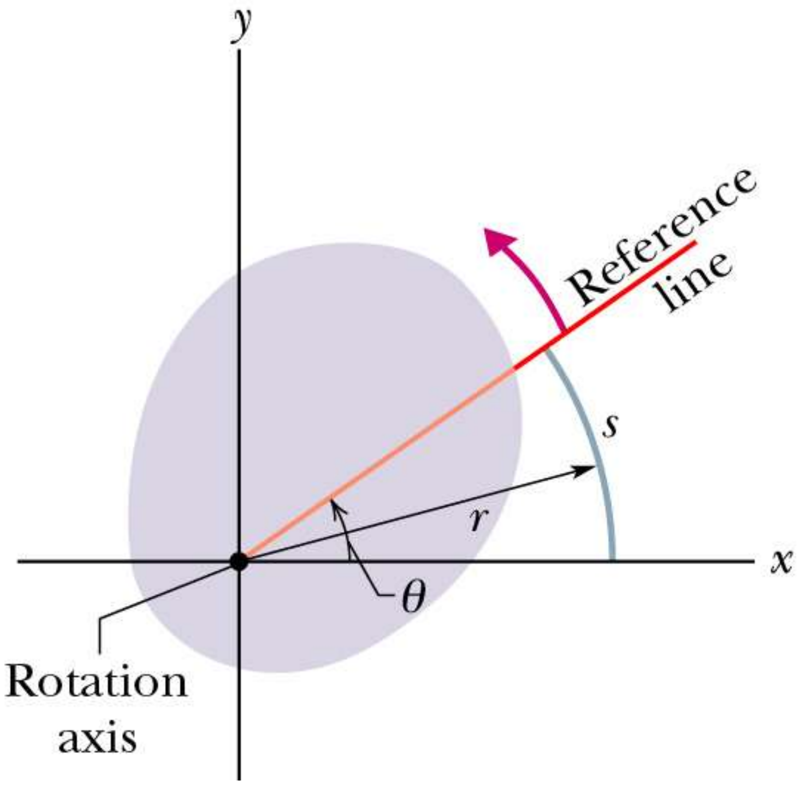




A rigid body rotates along a fixed axis

$$\theta = \frac{s}{r} \quad (radian\ measure)$$

$$s = arc\ of\ the\ circle$$

$$*\ circumference : s = 2\pi r$$

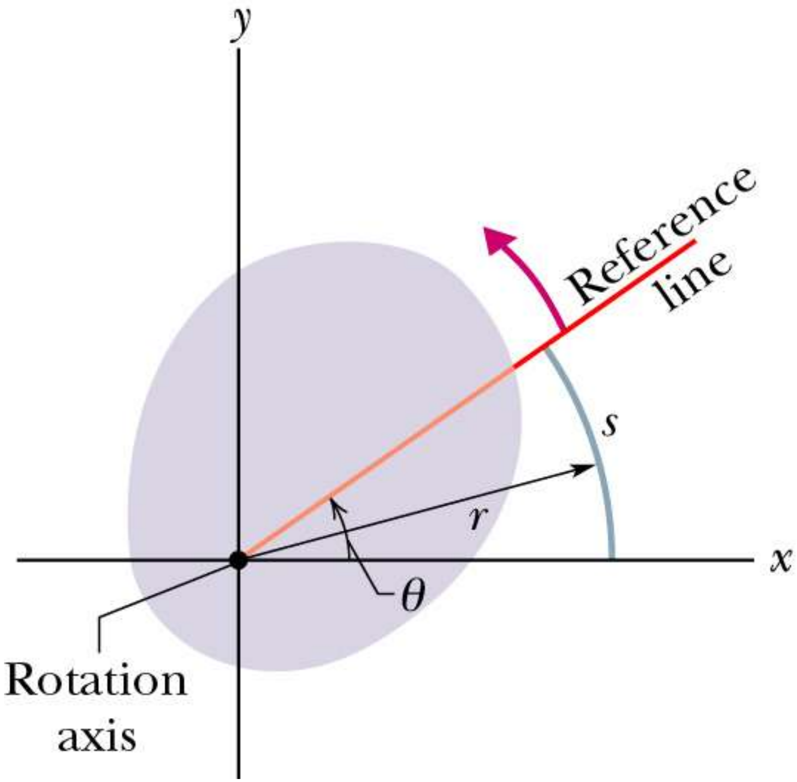
$$*\ 1\ rev : \Delta\theta = 2\pi = 360^0$$

$$*\ 1\ rad = \frac{360^0}{2\pi} = 57.3^0$$

$$s = r\theta$$

$$for\ \theta = 1\ rad$$

$$s = r$$



$$\theta \quad angular\ position$$

$$angular\ displacement :$$

$$\Delta\theta = \theta_2 - \theta_1$$

θ *angular position*

$\Delta\theta = \theta_2 - \theta_1$ *angular displacement*

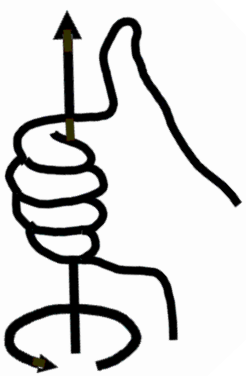
* *angular velocity*:

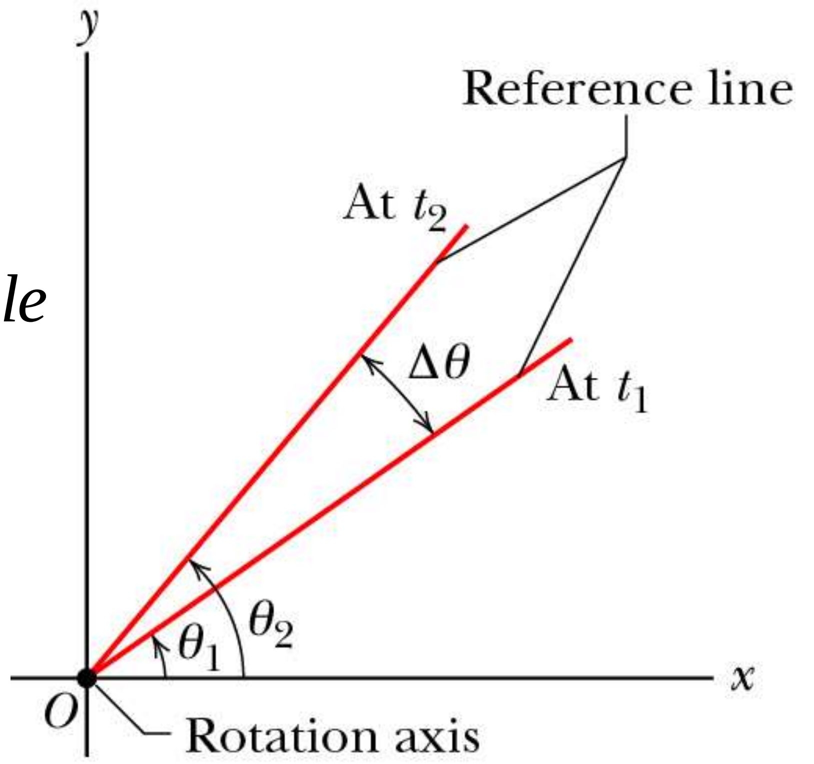
$$\omega_{avg} = \frac{\Delta\theta}{\Delta t} \qquad \omega = \frac{d\theta}{dt}$$

* ω *has a "direction" – right hand rule*

counterclockwise – positive

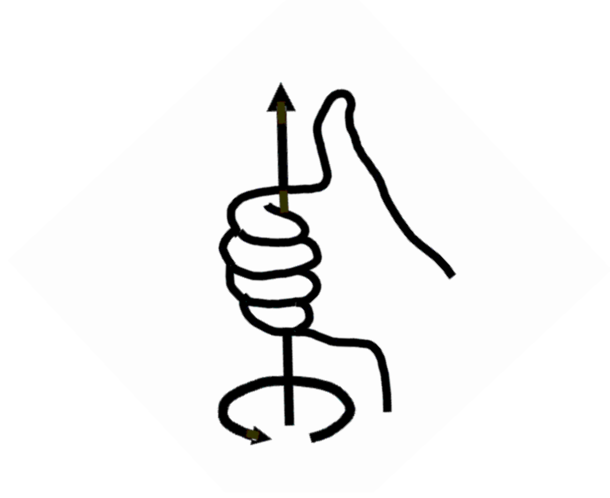
clockwise – negative





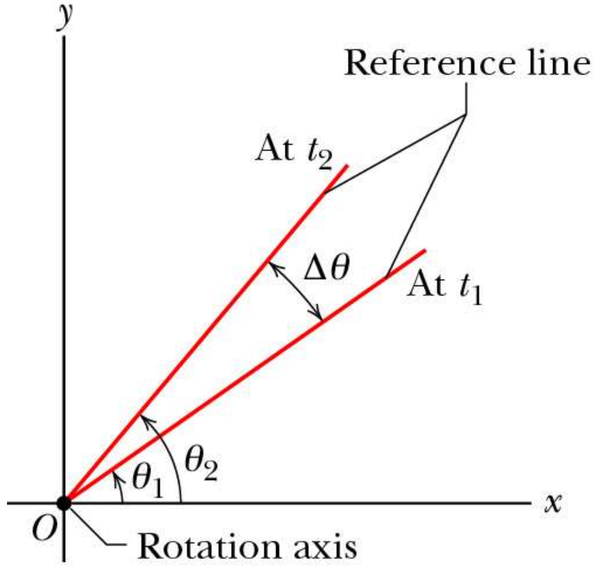
θ angular position

$\Delta\theta = \theta_2 - \theta_1$ angular displacement



$*$ angular velocity:

$$\omega_{avg} = \frac{\Delta\theta}{\Delta t} \qquad \omega = \frac{d\theta}{dt}$$



$*$ angular acceleration:

$$\alpha_{avg} = \frac{\Delta\omega}{\Delta t} \qquad \alpha = \frac{d\omega}{dt}$$

α is also a vector (right – hand rule)

$*$ for counterclockwise – rotation in $x-y$ plane

$$\vec{\omega} = \omega\vec{k}, \quad \vec{\alpha} = \alpha\vec{k}$$

* for constant angular acceleration :

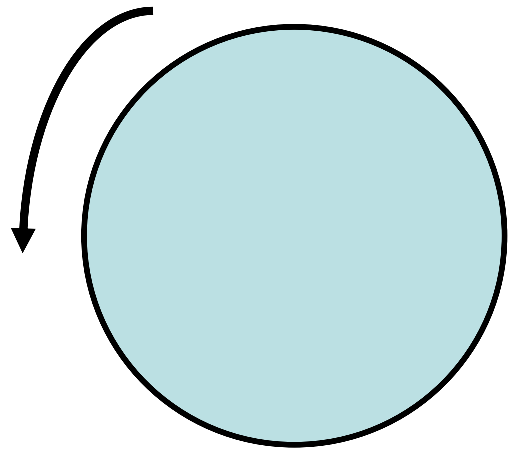
$$\Delta\omega = \omega - \omega_0 = \alpha t$$

$$\Delta\theta = \theta - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega^2 - \omega_0^2 = 2\alpha(\theta - \theta_0)$$

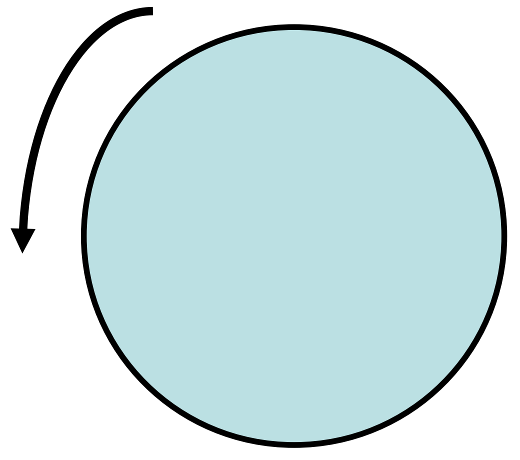
Rigid Body Under Constant Angular Acceleration	Particle Under Constant Acceleration
$\omega_f = \omega_i + \alpha t$	$v_f = v_i + at$
$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$	$x_f = x_i + v_i t + \frac{1}{2}at^2$
$\omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i)$	$v_f^2 = v_i^2 + 2a(x_f - x_i)$
$\theta_f = \theta_i + \frac{1}{2}(\omega_i + \omega_f)t$	$x_f = x_i + \frac{1}{2}(v_i + v_f)t$

A disk that initially spins at 2 revolutions/sec is braked uniformly to a stop in ½ second. What is its initial angular speed ω_0?



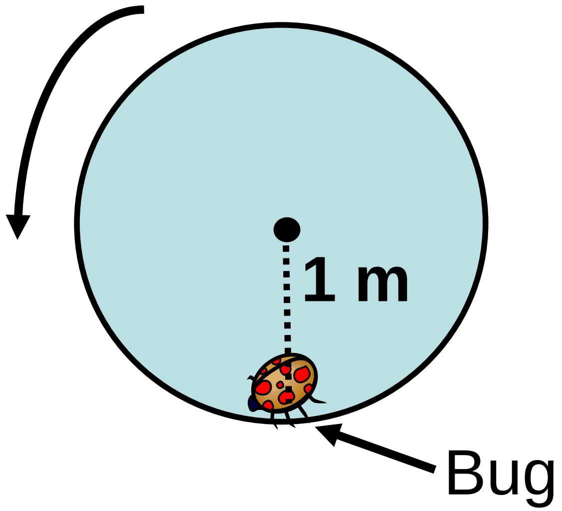
1. π / s
2. $2\pi / s$
3. $4\pi / s$
4. $8\pi / s$

A disk that initially spins at 2 revolutions/sec is braked uniformly to a stop in ½ second. What is the value of angular acceleration α ? (Negative α means stopping)



1. $-4\pi / s^2$
2. $4\pi / s^2$
3. $-8\pi / s^2$
4. $8\pi / s^2$

A disk that initially spins at 2 revolutions/sec is braked uniformly to a stop in ½ second. A bug is stuck on the outer edge 1 meter from the center. How many revolutions does the bug go during the time it takes the disk to stop?



1. 0.25 revolution
2. 0.5 revolution
3. 1 revolution
4. 1.5 revolution
5. 2 revolution

A flywheel turns 40 revolutions as it slows from ω_0 = 1.5 rad/s to a stop. How long does it take?

(A flywheel stores rotational energy. Need them in places such as generators with a varying electrical load)

A flywheel turns 40 revolutions as it slows from ω_0 = 1.5 rad/s to a stop. How long does it take?

(A flywheel stores rotational energy. Need them in places such as generators with a varying electrical load)

$$First\ \ method:$$

$$\omega^2 - \omega_0^2 = 2\alpha\theta$$

$$\alpha = \left(\frac{\omega^2 - \omega_0^2}{2\theta}\right) = \left(\frac{0 - \left(1.5\,{rad}/{s}\right)^2}{2\left(40\,rev\right)\left(2\pi\,{rad}/{rev}\right)}\right) = -4.48\times 10^{-3}\,{rad}/{s^2}$$

$$\omega - \omega_0 = \alpha t$$

$$t = \left(\frac{\omega - \omega_0}{\alpha}\right) = \left(\frac{0 - 1.5\,{rad}/{s}}{-4.48\times 10^{-3}\,{rad}/{s^2}}\right) = 335\,\mathrm{sec}$$

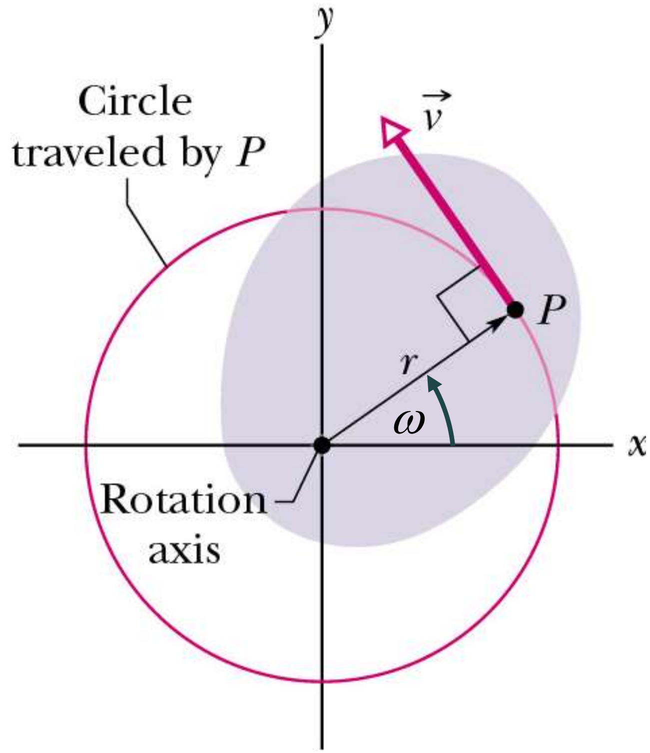
$$Second\ \ method:$$

$$t = \left(\frac{\theta}{\omega_{AV}}\right) = \left(\frac{\left(40\,rev\right)\left(2\pi\,{rad}/{rev}\right)}{0.75\,{rad}/{s}}\right) = 335\,\mathrm{sec}$$

$$s = r\theta$$

$$\frac{ds}{dt} = r\frac{d\theta}{dt}$$

$$V_t = \omega r$$

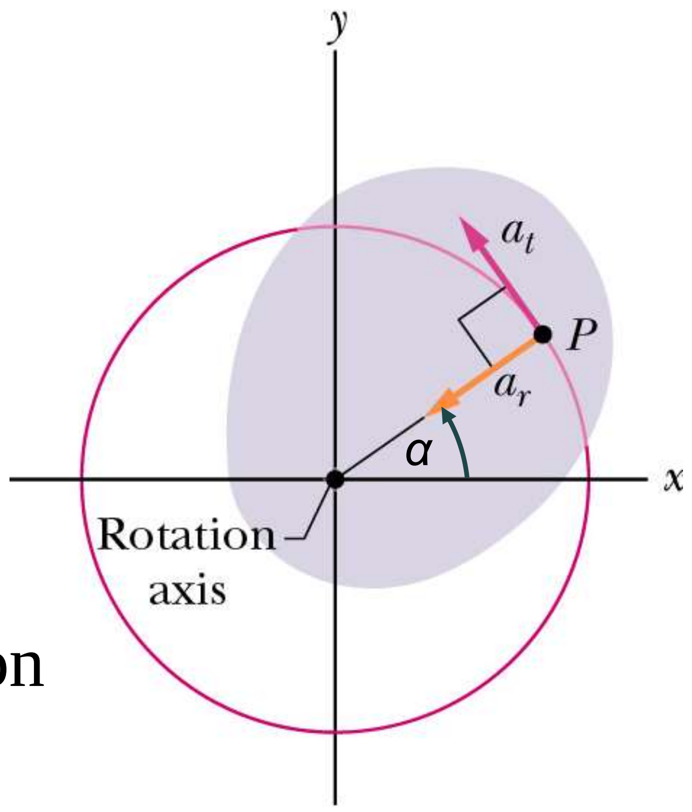


$$T = \frac{2\pi r}{V_t} = \frac{2\pi r}{\omega r} = \frac{2\pi}{\omega}$$

$$V_t = \omega r$$

tangential acceleration

$$a_t = \frac{dV_t}{dt} = \frac{d\omega}{dt} r = \alpha r$$



(b)

$$V_t = \omega r$$

"centripetal" (radial) acceleration

$$a_r = \frac{V_t^2}{r} = \frac{\omega^2 r^2}{r} = \omega^2 r$$

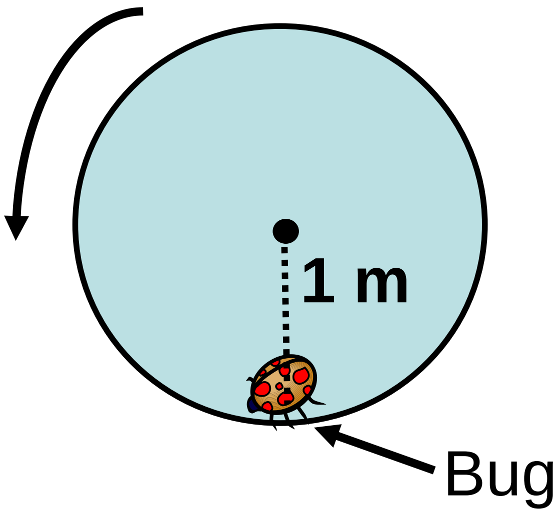
$$s = r\theta$$

$$V_t = \omega r$$

$$a_t = \alpha r \qquad a_r = \omega^2 r$$

A disk that initially spins at 2 revolutions/sec is braked uniformly to a stop in ½ second. A bug is stuck on the outer edge 1 meter from the center.

What is the initial angular speed of the bug?

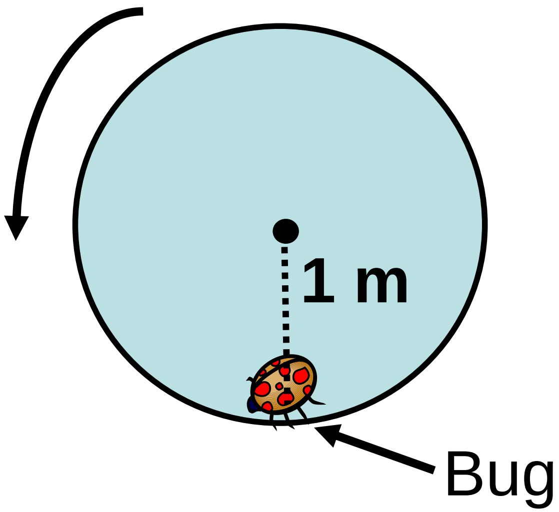


What is the initial tangential speed of the bug?

What is the angular acceleration of the bug?
(magnitude and direction CW or CCW)

What is the tangential acceleration of the bug?
(magnitude and direction CW or CCW)

A disk that initially spins at 2 revolutions/sec is braked uniformly to a stop in ½ second. A bug is stuck on the outer edge 1 meter from the center.



What is the initial angular speed of the bug?
4π/s

What is the initial tangential speed of the bug?
12.6 m/s

What is the angular acceleration of the bug?
(magnitude and direction CW or CCW)
CW, 8π/s

What is the tangential acceleration of the bug?
(magnitude and direction CW or CCW)
CW, 25.1 m/s