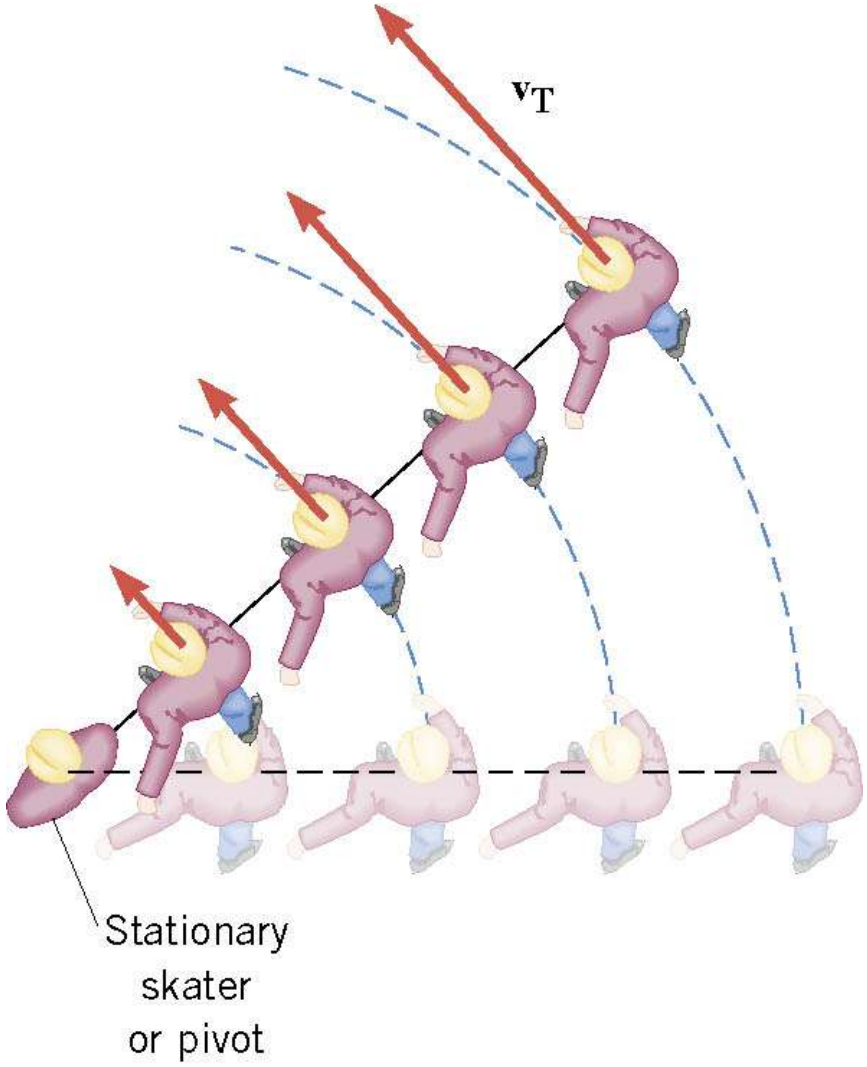
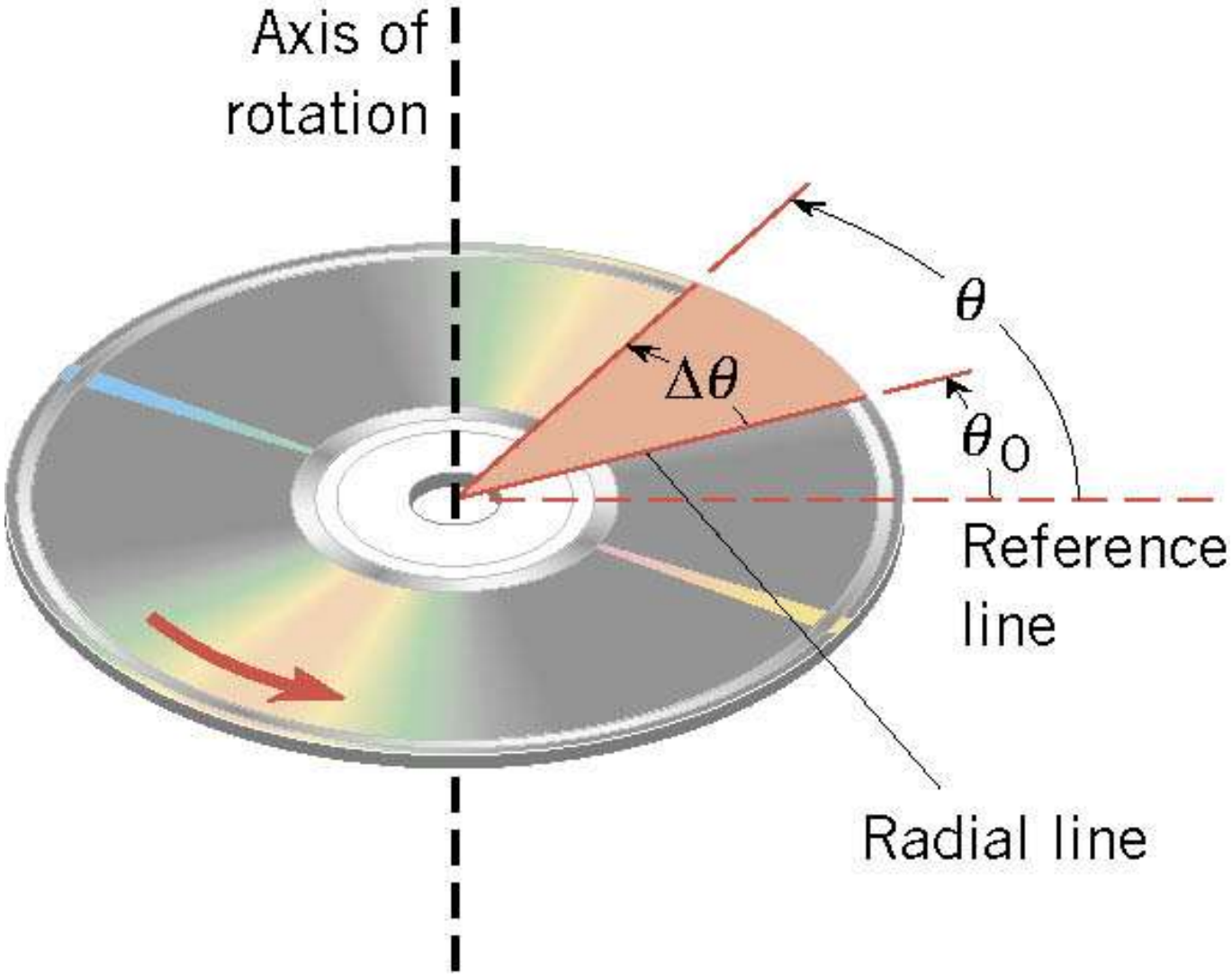
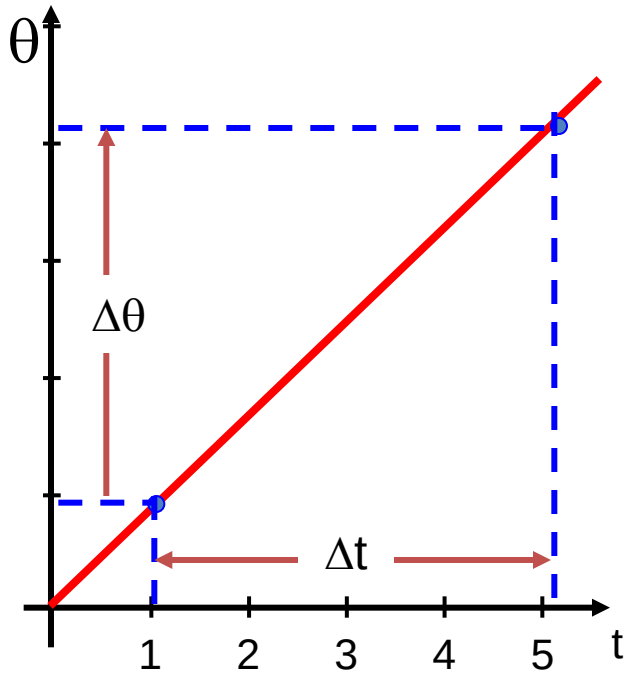
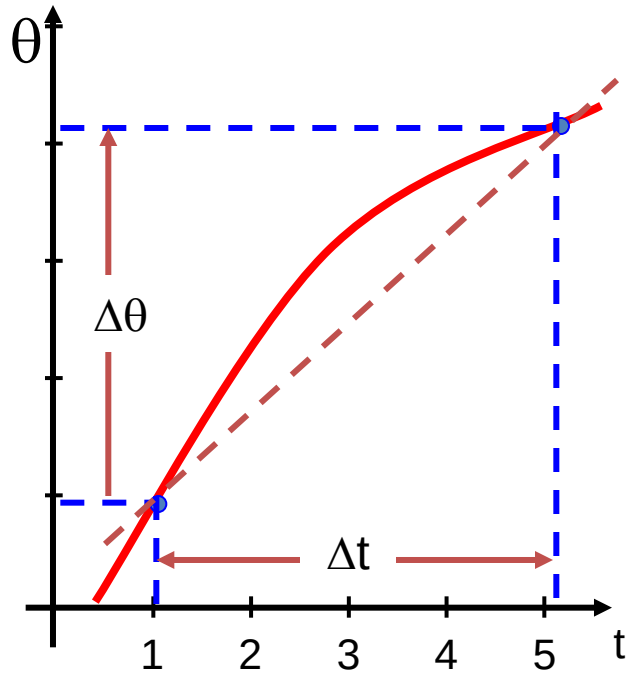

v_T
Stationary
skater
or pivot


Axis of rotation
θ
Δθ
θ0
Reference line
Radial line

Average Velocity

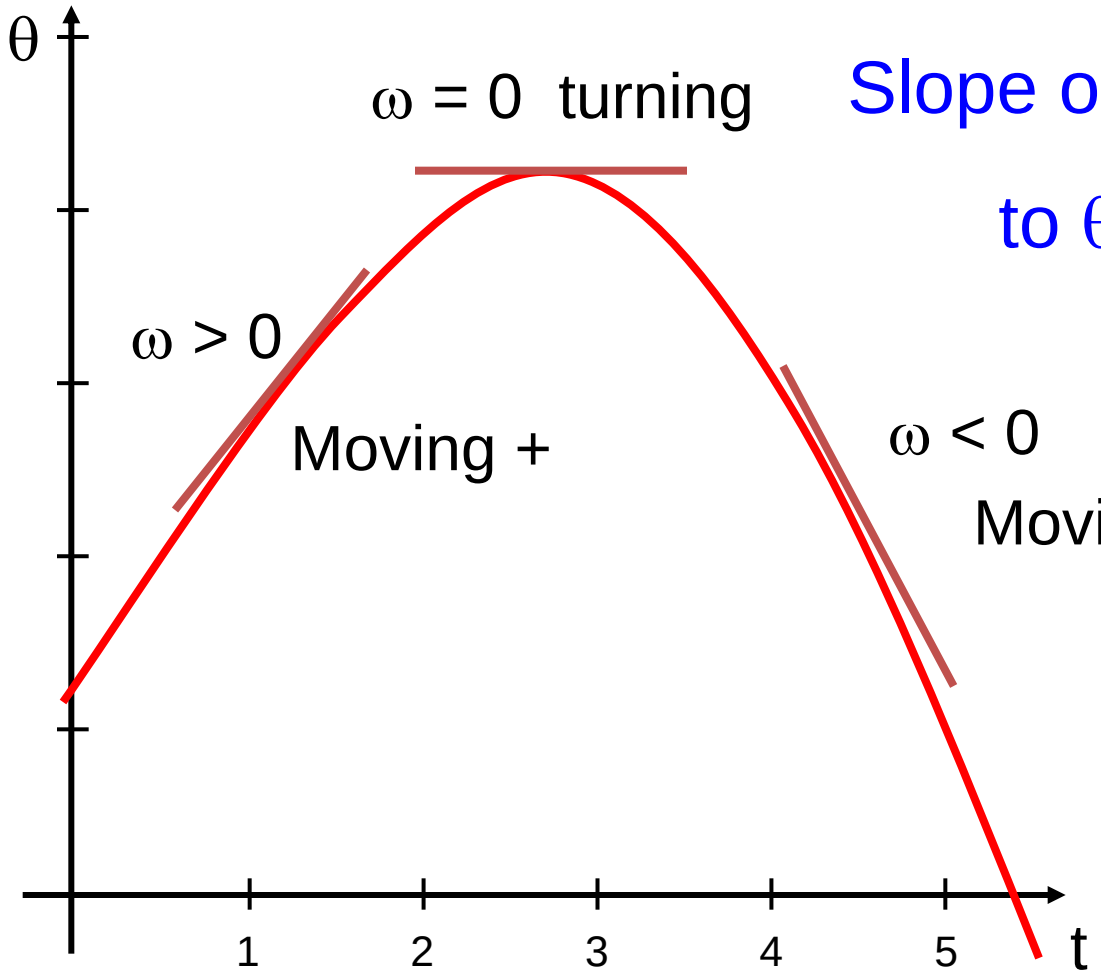
$$\vec{\omega}_{average} = \frac{\Delta\vec{\theta}}{\Delta t}$$



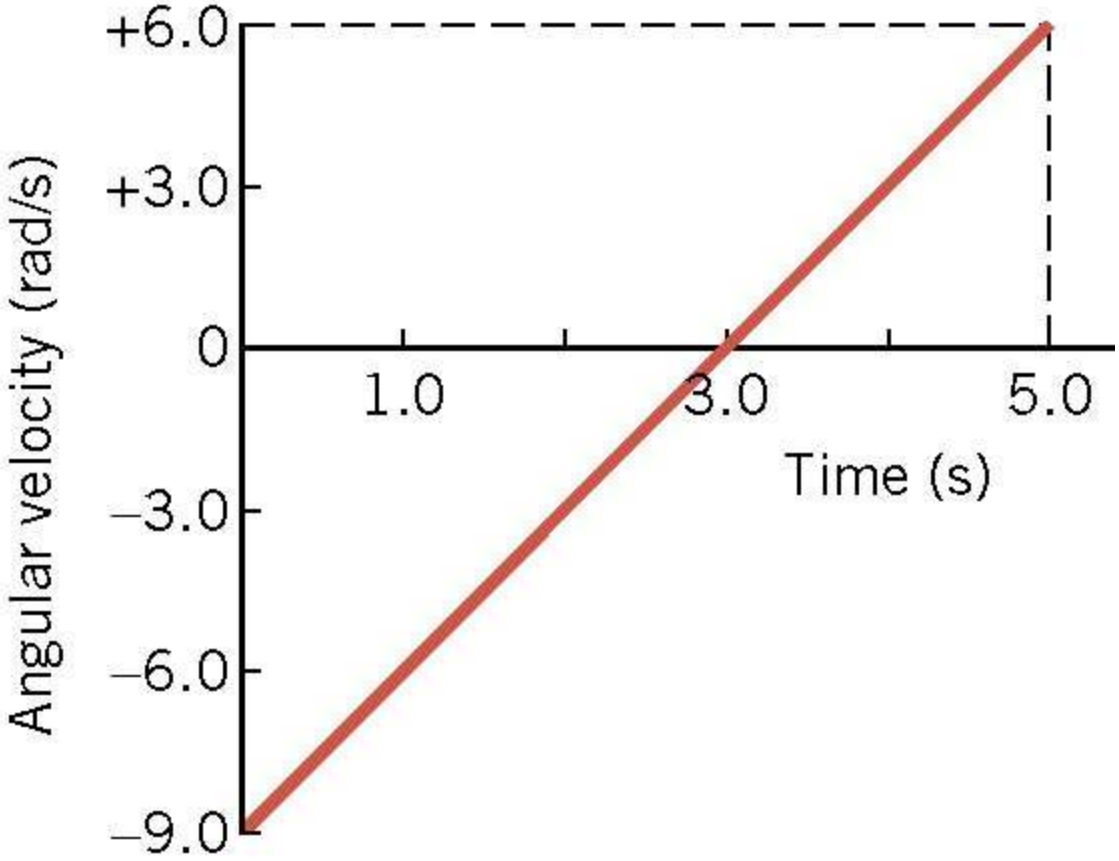


Velocity

$$\vec{\omega} = \lim_{\Delta t \to 0} \frac{\Delta \vec{\theta}}{\Delta t} = \frac{d\vec{\theta}}{dt}$$



Slope of line tangent to θ-t graph

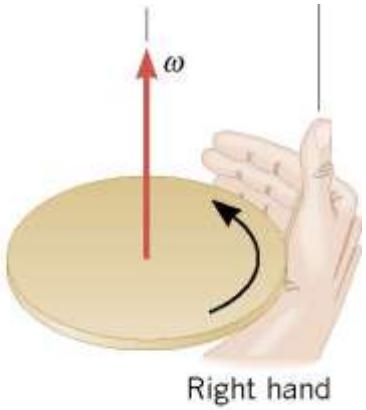


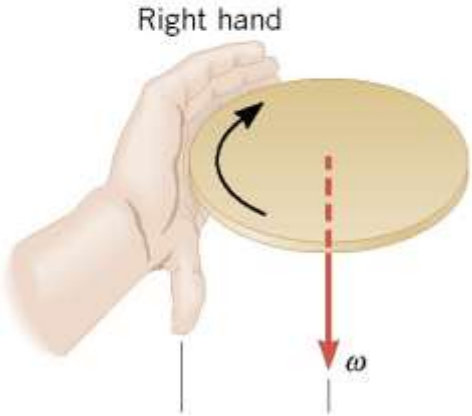
Work with constant α, so ω-*t* graph is linear. Slope of ω-*t* graph is α.

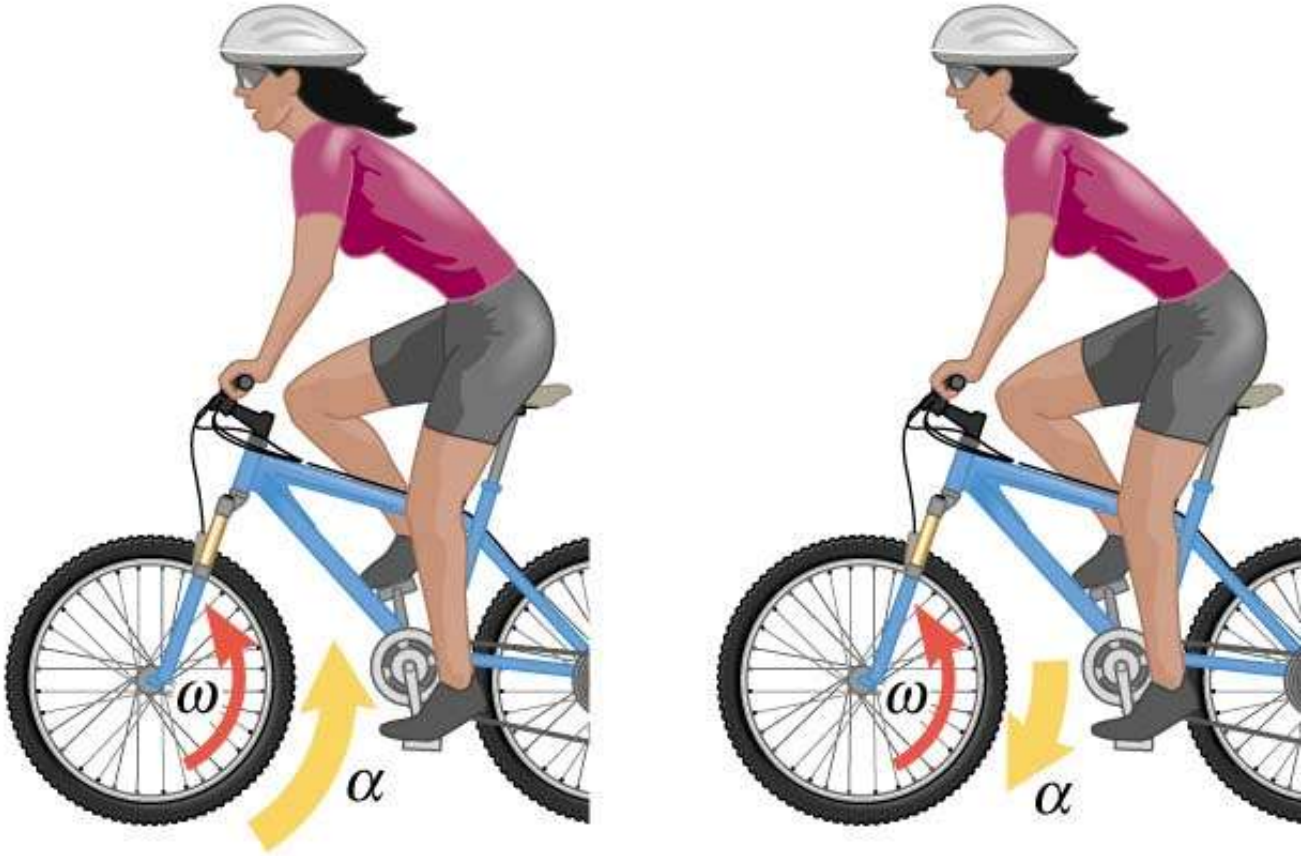
$y = b + mx \Rightarrow \omega_f = \omega_i + \alpha t$

$$\omega_{ave} = \frac{\omega_f + \omega_i}{2}$$

Vector Direction





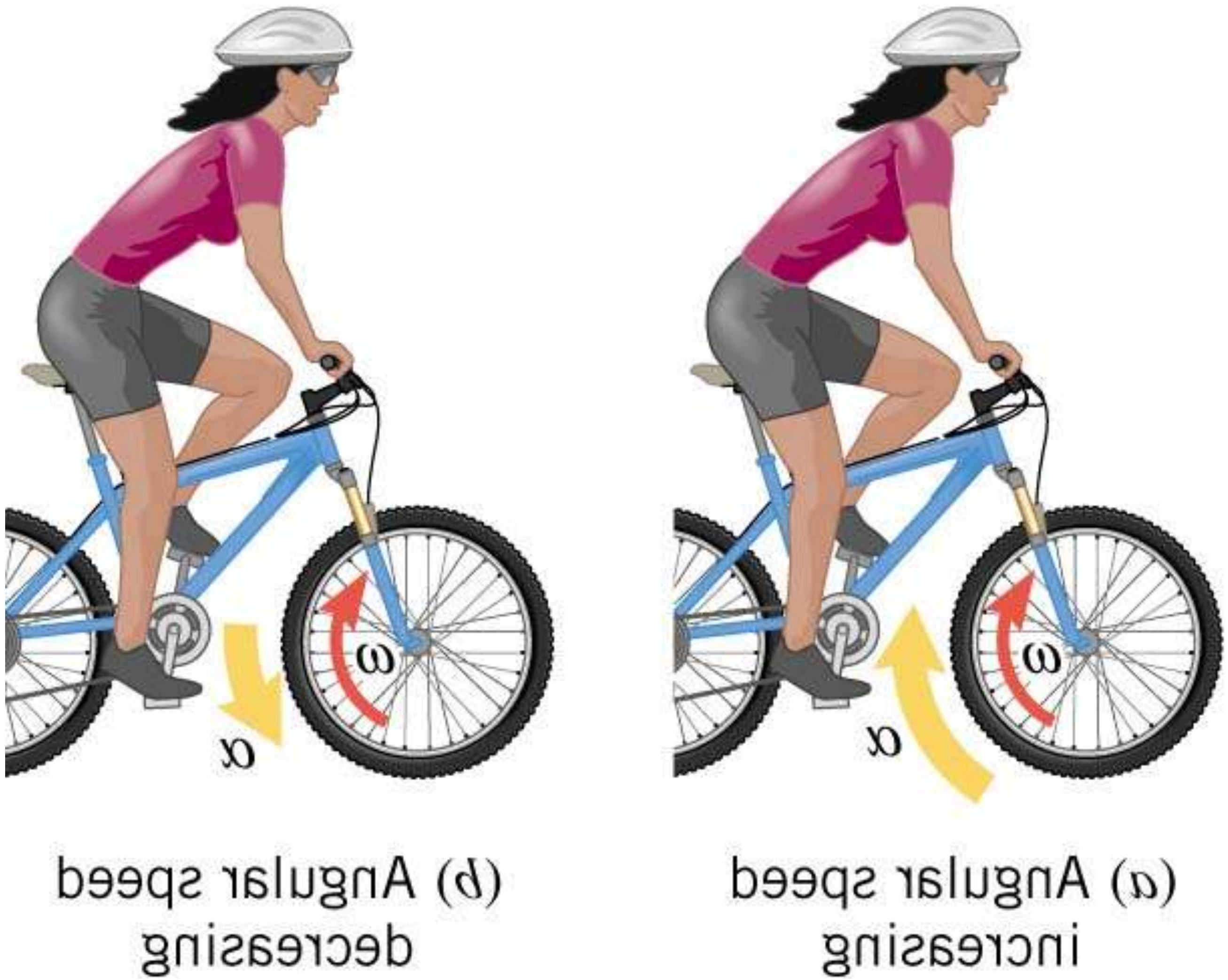


(*a*) Angular speed increasing

(*b*) Angular speed decreasing

$\vec{\alpha} \uparrow\uparrow \vec{\omega} \Leftrightarrow$ speeding up

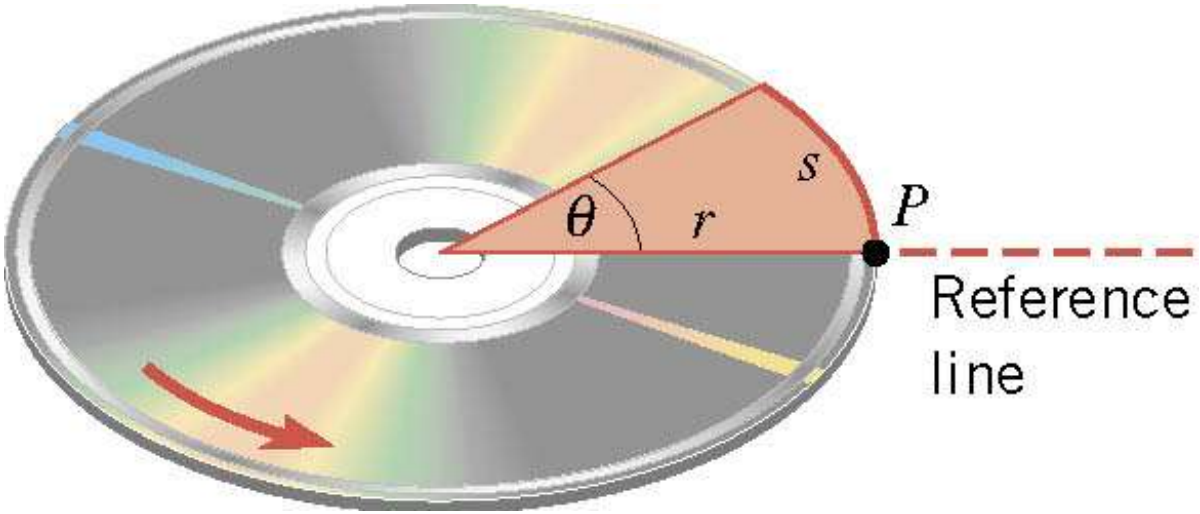
$\vec{\alpha} \uparrow\downarrow \vec{\omega} \Leftrightarrow$ slowing down



$\vec{\alpha} \uparrow\uparrow \vec{\omega}$ $\Leftrightarrow$ speeding up

$\vec{\alpha} \uparrow\downarrow \vec{\omega}$ $\Leftrightarrow$ slowing down

Tangential Variables



$$s = r\theta$$

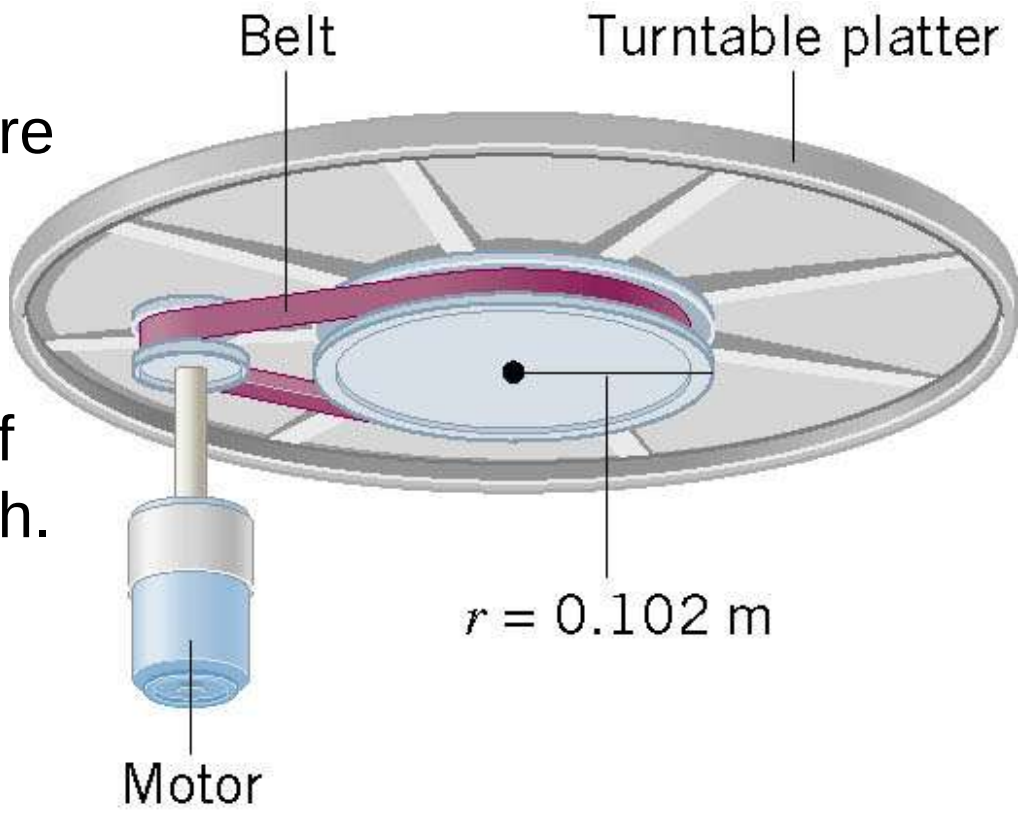
$$\frac{ds}{dt} = r\frac{d\theta}{dt} \quad \Rightarrow \quad v_{tan} = r\omega$$

$$\frac{dv_{tan}}{dt} = r\frac{d\omega}{dt} \quad \Rightarrow \quad a_{tan} = r\alpha$$

Belts

Small disk and big disk are connected by belt.

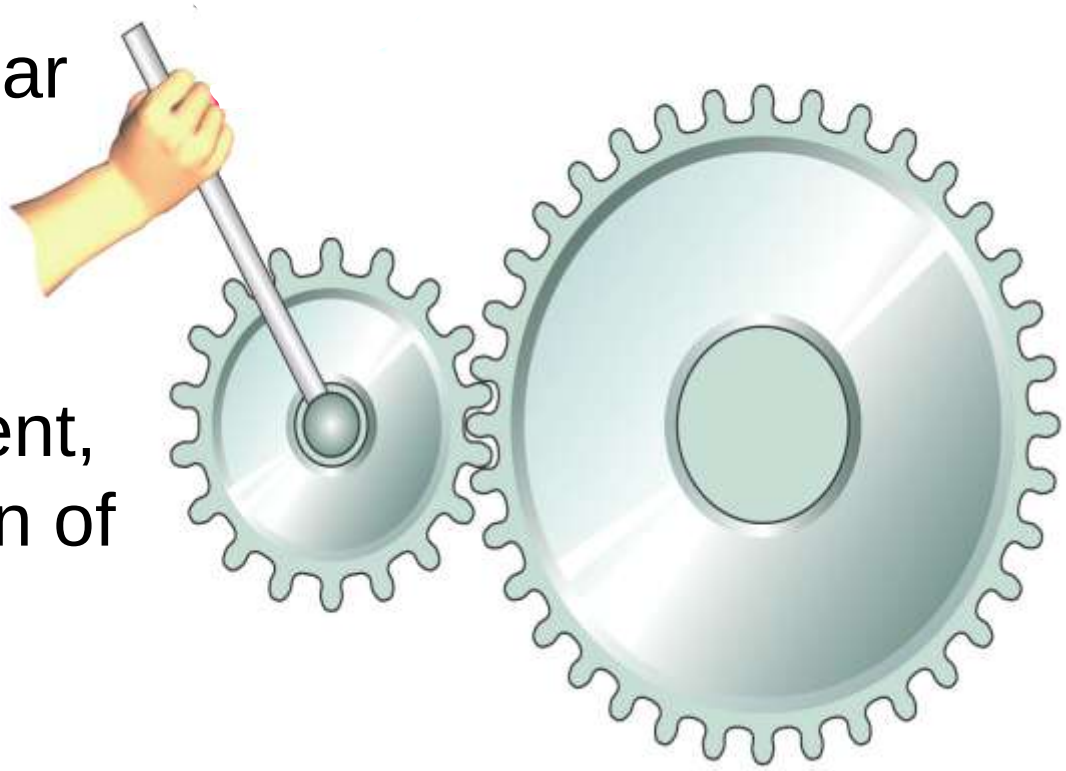
Tangential displacement, velocity, & acceleration of disks and belt must match.



Geared Wheels

Small gear and big gear are touching and cannot slip.

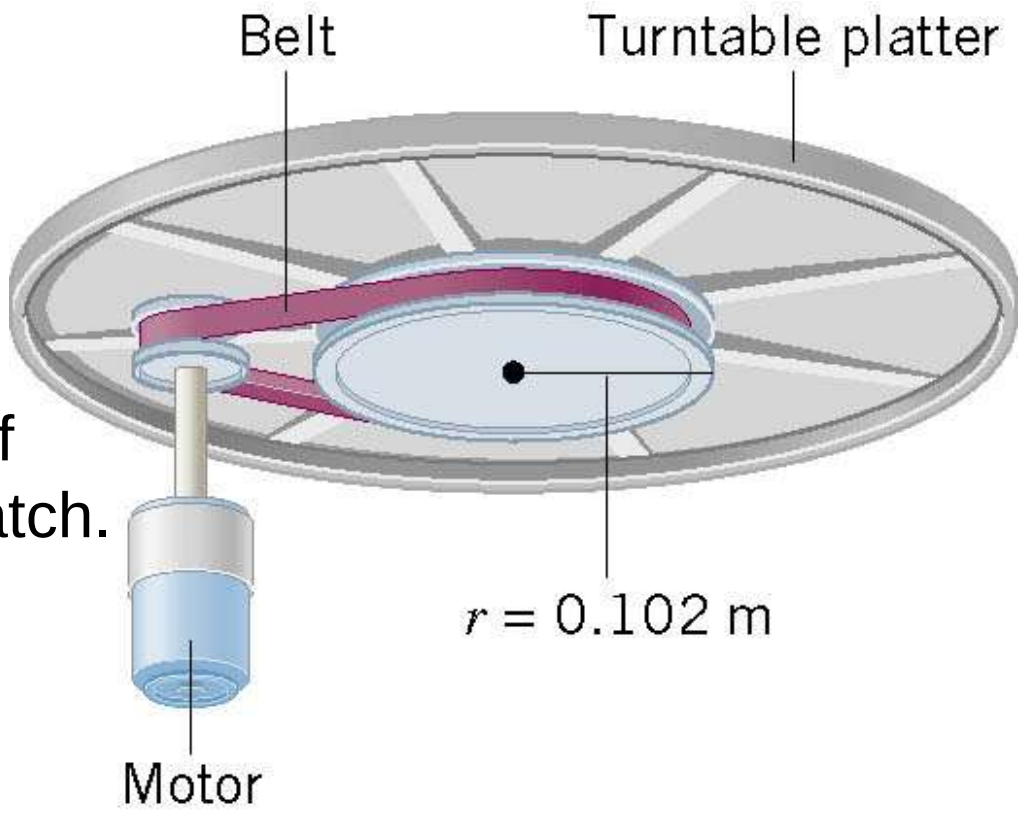
Tangential displacement, velocity, & acceleration of gears must match.



Common Axles

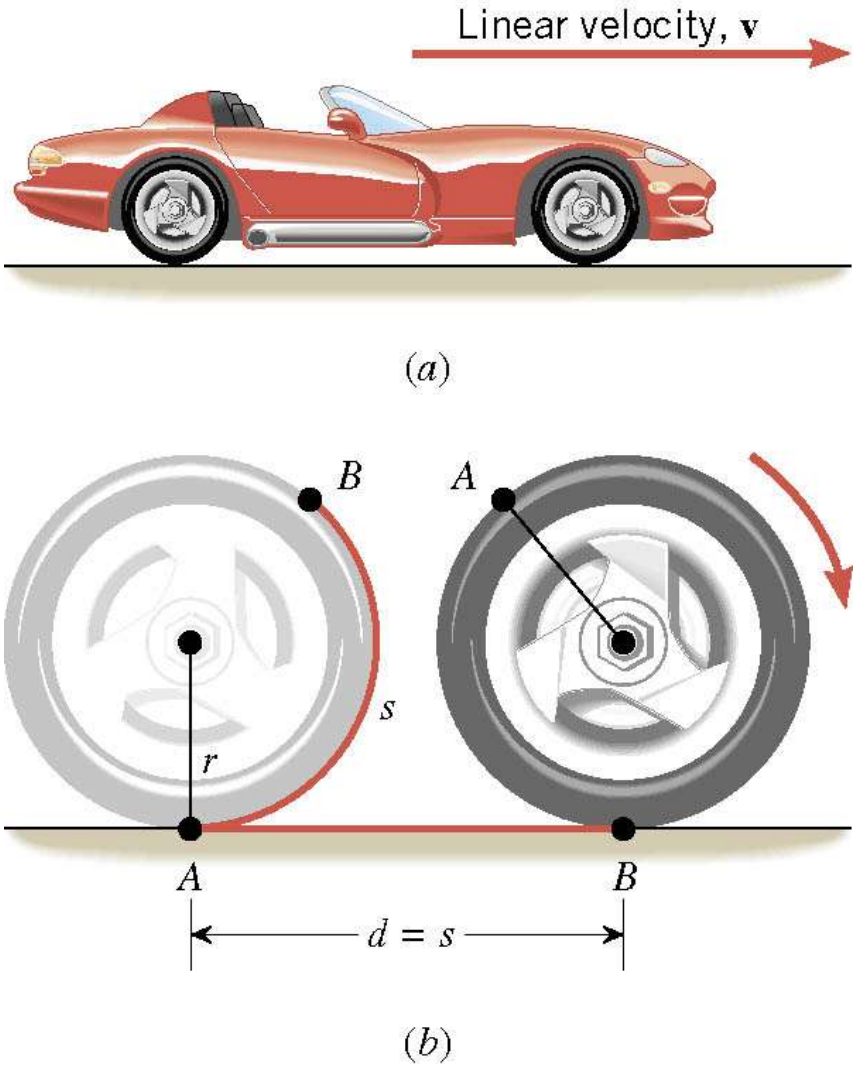
Small disk and motor are connected by an axle.

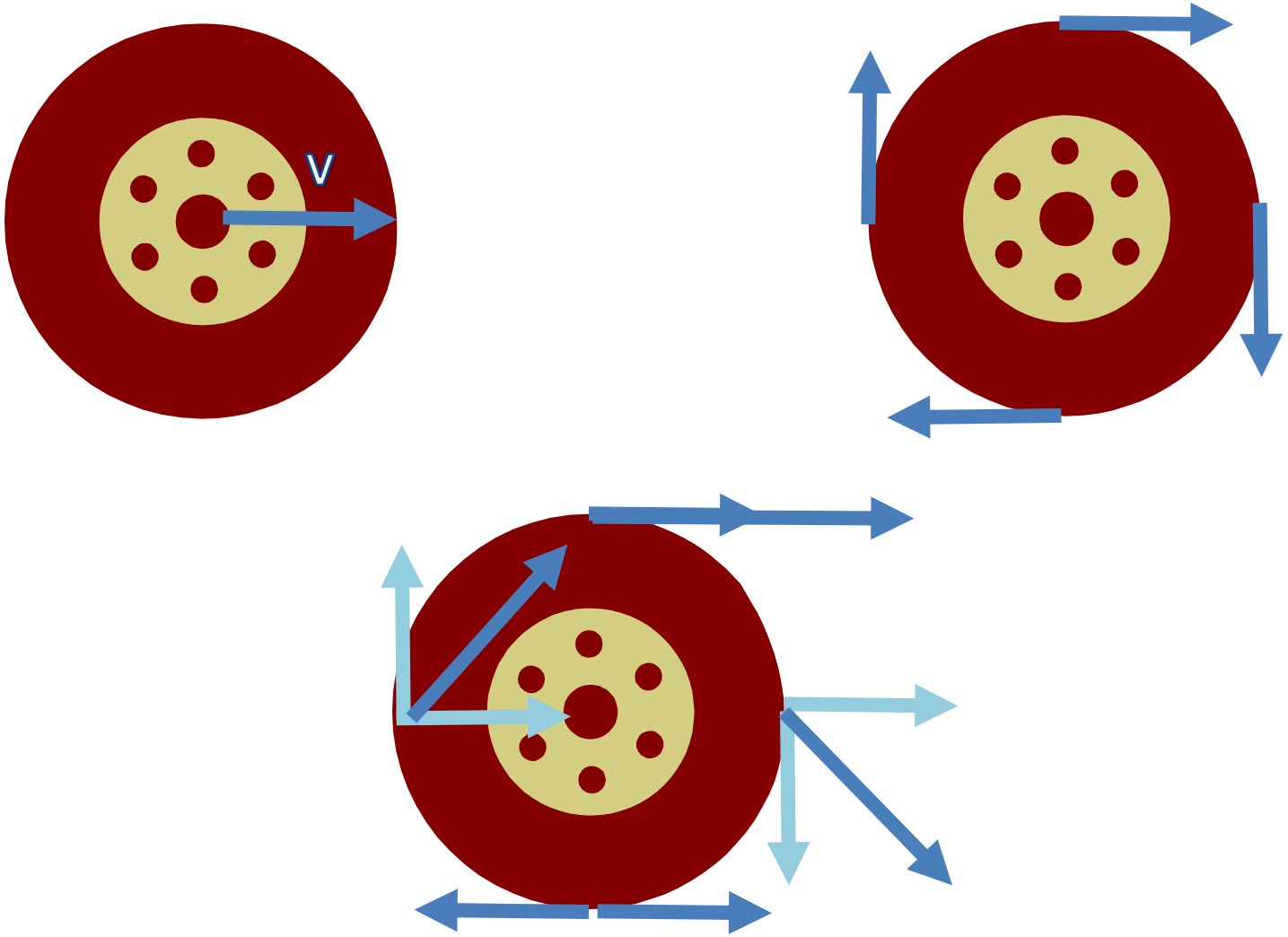
Rotational displacement, velocity, & acceleration of disks and motor must match.



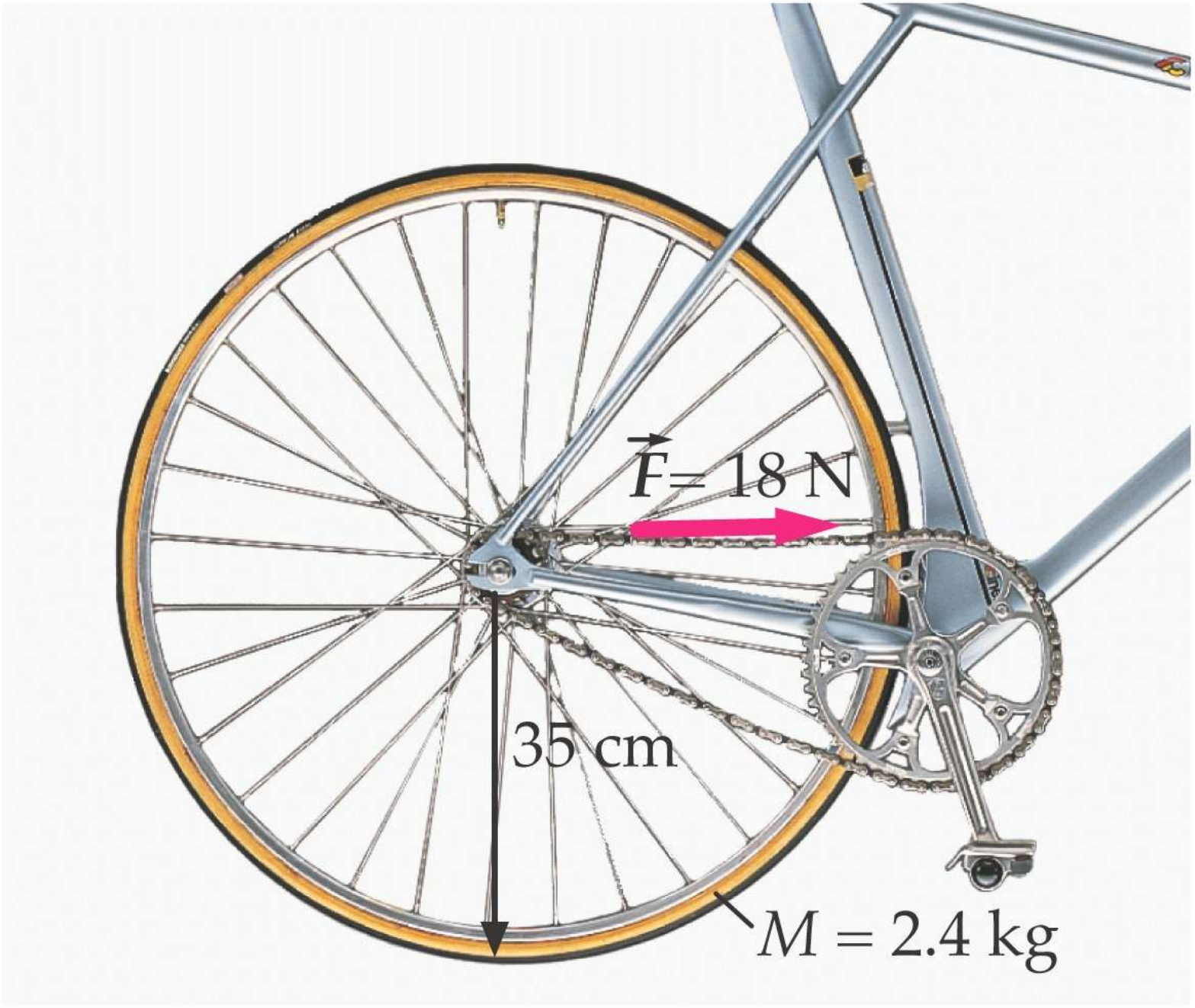
Rolling

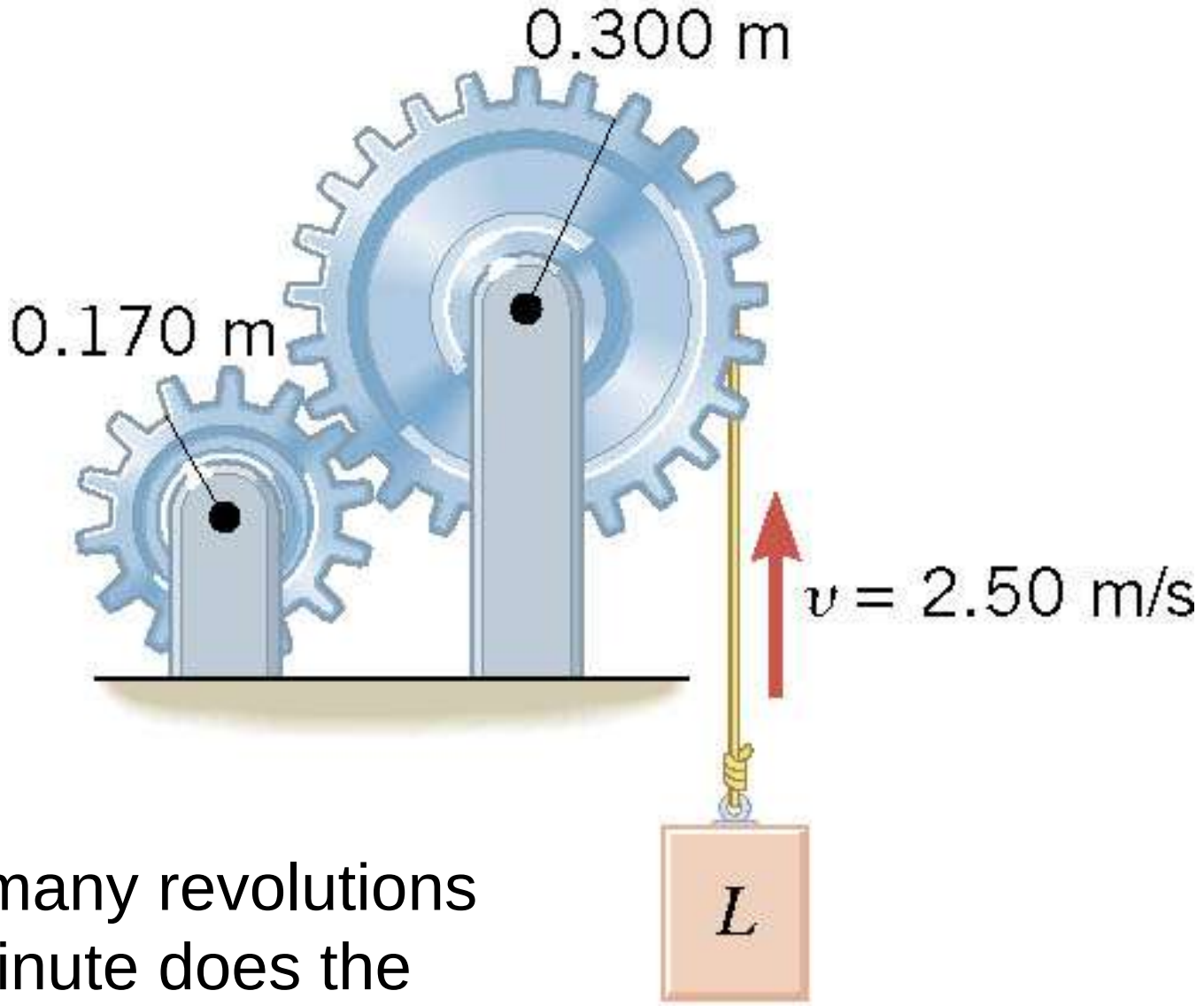
If wheel does not slip, tangential displacement, velocity, & acceleration must match linear displacement, velocity, & acceleration.



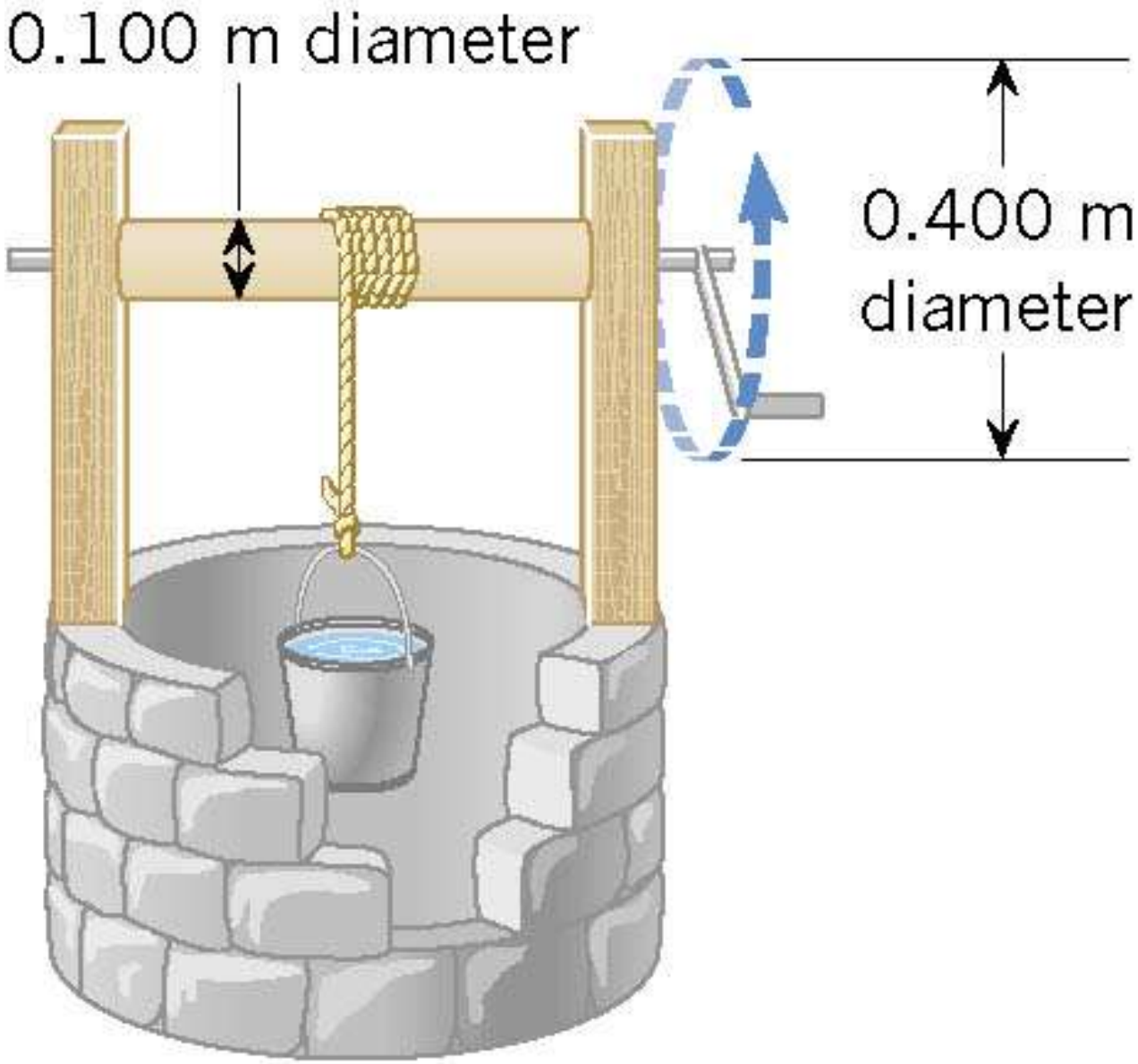


Point of contact is at “rest”


$\vec{F}$ = 18 N
35 cm
M = 2.4 kg



How many revolutions per minute does the small gear make?


0.100 m diameter
0.400 m
diameter