

PhyzGuide: Rotational Kinematics

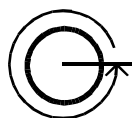
translational

DISPLACEMENT

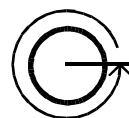
rotational

Name Displacement
Symbol x, y, z (or s)
Units Meters are the SI units, feet, yards, light-years and many others are also used.

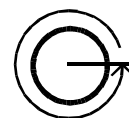
Name Angular displacement
Symbol θ
Units Radians are the SI “units,” degrees and revolutions are also used:
 $1 \text{ rev} = 2\pi \text{ rad} = 360^\circ$



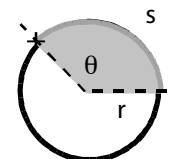
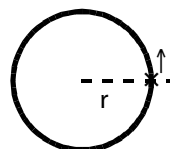
1 revolution



2 radians



360°

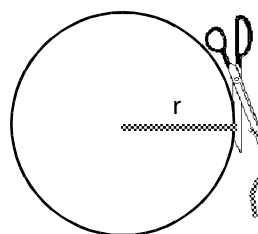


If a point (x) rotates through an angle θ along the arc of a circle of radius r as shown above, then the arclength (linear distance) s is:

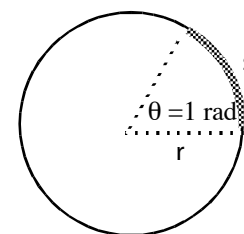
$$s = r\theta$$

ONLY if the angle θ is measured in radians. This simple relation between angle and arclength makes the radian a convenient and “natural” unit of angular measure.

A RADIAN? What’s a RADIAN?!



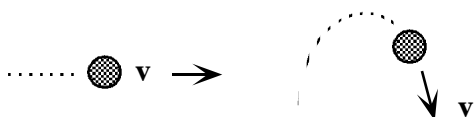
If you stretched a string from the center of a circle to the edge and cut it as shown, you’d have a length of string equal to the circle’s radius.



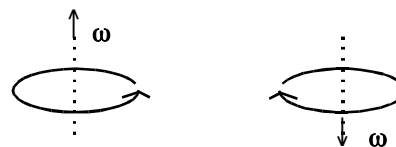
$$s = r$$

Now wrap that length of string around the circle as far as it will go. The arclength covered is equal to the radius, and the angle covered is 1 radian.

Name Velocity
Symbol v
Defn. $v = \Delta x / \Delta t$
 (vector: $\mathbf{v} = \Delta \mathbf{x} / \Delta t$)
 Velocity is the rate of change of position. The direction of the vector \mathbf{v} is the direction of motion.



Name Angular velocity
Symbol ω
Defn. $\omega = \Delta \theta / \Delta t$
 (vector: $\boldsymbol{\omega} = \Delta \boldsymbol{\theta} / \Delta t$)
 Angular velocity is the rate of change of angular position. The direction of the vector $\boldsymbol{\omega}$ is the axis of rotation (via a right-hand rule).



Name Acceleration
Symbol a
Defn. $a = \Delta v / \Delta t$
 (vector: $\mathbf{a} = \Delta \mathbf{v} / \Delta t$)
 Acceleration is the rate of change of velocity. Acceleration occurs when speed *or* direction of motion changes.

Name Angular acceleration
Symbol α
Defn. $\alpha = \Delta \omega / \Delta t$
 (vector: $\mathbf{a} = \Delta \boldsymbol{\omega} / \Delta t$)
 Angular acceleration is the rate of change of angular velocity. Angular acceleration occurs when angular speed *or* plane of rotation changes.